PUBLIC LIBRARY

AMERICAN MACHINIST

JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 13, No. 35. WEEKLY. | NEW YORK, THURSDAY, AUGUST 28, 1890. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

COPYRIGHT 1890, BY AMERICAN MACHINIST PUBLISHING COMPANY. For Sale Everywhere by Newsdealers. ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Key-seating Machine.

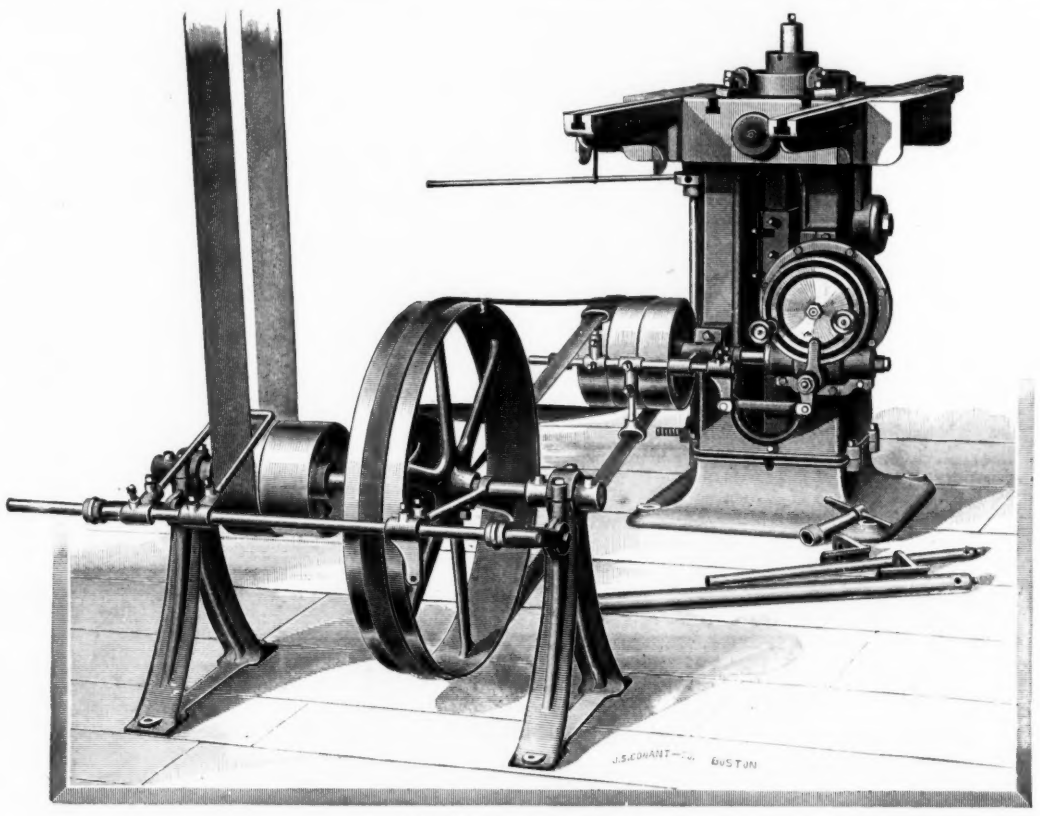
We present herewith an engraving showing a new key-seating machine, in which the crank motion usually employed in such machines is dispensed with, and the motion of the bar carrying the cutter secured by means of a rack and pinion movement driven by a worm and wheel running in a casing filled with oil. The engraving gives a rear view of the machine, as it is from the rear that the mechanism can best be seen.

On the face of the worm-wheel is a disk in which are two slots carrying stops which reverse the motion by shifting the open and crossed belts which run from the countershaft, as shown. These belts run at a high speed, and drive the worm shaft. A quick return motion is secured by means of the usual large pulley on countershaft for driving the return belt, and equal rapidity of shifting motion is secured by placing the stop which acts at the end of the cutting stroke further from the center of the disk, where it not only has a more rapid motion, but acts upon the shifting lever nearer its center. The stroke can readily be changed from one inch to the full capacity of the machine, without stopping.

To provide for the forward motion of the tool in the cut, the vertical guide is arranged to move forward in ways provided at the top and bottom, being fed forward by means of wedges, which are moved by the lever seen at the left of the machine. The bar to which the tool is secured is a plain round one, and the cutters are so made that their shape is unchanged by grinding.

Work is secured to the table by means of bolts in the usual manner, slots being provided for the purpose, and this table is mounted upon heavy trunnions in such a way that it can be inclined in either direction to produce tapered key-ways, and as the inclination of the table, when set, always bears the same relation to the line of motion of the cutter, the taper when once set by means of the indexed dial, provided for the purpose, remains uniform, regardless of any change in the depth of cut or length of hub. The cutter bar is secured to the crosshead by means of a **V** groove, which always secures accurate alignment, and all the working parts are thoroughly protected from dust and chips. The table is provided with extensions for pulleys of large diameter, and there is a stop for the feed motion, by means of which any number of key-ways can be made duplicates of each other, so that keys will interchange. Key seats 1″ wide by 6″ long have been cut on these machines in three to four minutes; 1¼″ wide by 12″ long in twelve minutes.

The machines are built in five sizes, the smallest for cutting key-seats up to 1½″ wide 10″ long, and the largest for key-seats up to 3½″ wide 30″ long, by the Giant Key-seater Co., East Saginaw, Mich.

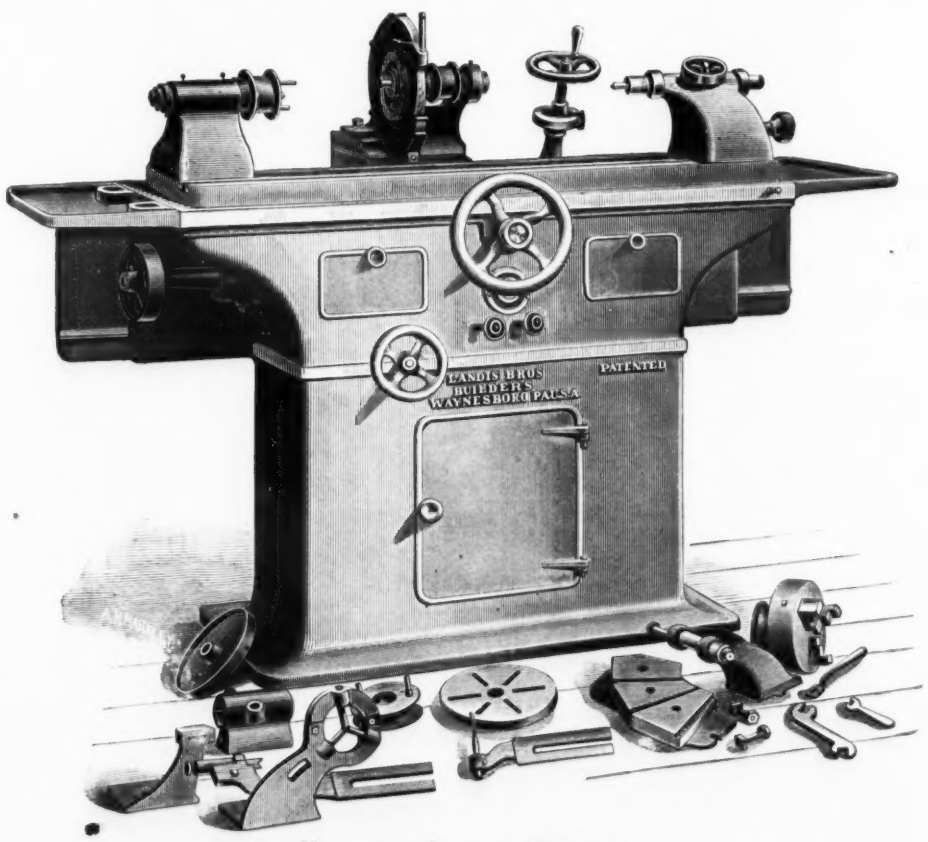


KEY-SEATING MACHINE.

The Brotherhood of Locomotive Firemen will hold its biennial convention at San Francisco, Cal., beginning Monday, September 8. The reception will be on Monday at two o'clock, and will undoubtedly be an enjoyable affair.

Universal Grinding Machine.

On this and the succeeding page we give illustrations of a universal grinding machine, designed by Mr. A. B. Landis, and which embodies some of the ideas he has brought forward from time to time in our columns in his articles upon tool-grinding processes, besides others which are now made public for the first time.



UNIVERSAL GRINDING MACHINE.

In this machine, the platen upon which is mounted the head and foot-stocks, does not move to carry the work past the wheel in grinding, but is stationary, while at the back of the machine is a long platen, which has a traversing motion, and upon this platen is mounted the carriage which carries the grinding wheel. The carriage is movable upon the platen endwise, and can be clamped to it at any point, so that the motion of the platen can be made central upon its guiding surfaces, regardless of the length of the piece to be ground or the limits between which the wheel may travel.

Fig. 3 (page 2), which is a cross-section of the machine through the middle of its length, shows the manner of attaching this traversing platen to the bed, and the carriage to the platen.

The head-stock in this machine is fixed rigidly to the pivoted platen, the foot-stock only being movable, and, as shown by Fig. 3, the latter is secured to the platen by a bolt, which is fitted to a **T** slot at such an angle that, when it is drawn up, the foot-stock is drawn tightly against the square shoulder *A* at the back, upon which, of course, there is no wear of consequence, and thus exact alignment is secured. The foot-stock spindle is moved forward to the work by means of the knurled disk shown in Fig. 11, and, as shown by this figure, the disk is so connected with a spiral spring that the spindle may be held to the work by this spring, and with any desired degree of tension, or the spindle may be made rigid by tightening the lock nut above, the lower one being for altering the tension on the spring.

The head-stock spindle with its bearings can be removed from the head-stock by loosening the two clamping screws shown, and can be put into the head, a plan view of which is shown in different positions by Figs. 6, 7, 8 and 9. This latter head is secured to a plate, in which there are three slots at angles of 90°, 60°, and 30°, with the slots in the platen, so that these angles, which usually are those most used, can be ground without disturbing the adjustment of the pivoted platen, and, of course, plates having slots at any desired angle can be provided. In line with the centers is a pan formed in the platen, over which all grinding is done, and which catches all water and material ground off, and conducts it by suitable channels shown, to a vessel on the floor; all needed shields and guards being provided, by which it is prevented from flying about the machine, and, as will be seen by reference to Figs. 6, 7, 8 and 9, such grinding as is there being done is also over this pan.

For other taper or angular grinding, the platen upon which the head and foot-stocks

are mounted swivels either way 15° from the center line, as shown by Figs. 4 and 6, and is clamped at each end simultaneously by the hand-wheel shown at the left in Fig. 5, which also shows the arrangement of the clamping device. At the right-hand end of the platen are two sets of graduations, by which it may be set at any angle up to 15°, or to any taper up to 6″ to the foot. Beneath the platen is a tangent adjusting screw, the nut of which can be connected or disconnected from the platen at will, and the clamping device can be swung to either side of the center of the machine, thus allowing for the wide range of angular adjustment.

A section of the grinding spindle and boxes is shown at Fig. 10, where it is seen that things are so arranged that dust is excluded from the bearings, the spindle can readily be drawn out or the wheel changed. The head which supports the grinding spindle is made very heavy, with the object of absorbing vibration, and it can be made to travel to or from the center line at any desired angle from 0° to 90°, the arrangement for giving this motion being shown by Fig. 3, where it is seen that a screw is provided, which swings around with the head, and is provided with a bevel pinion that is driven from the large ring bevel gear, a section of which is shown below the pinion, and which in turn is given motion by means of a pinion which is at the lower end of the shaft shown back of the foot-stock in Fig. 1. At the upper end of this shaft is the hand-wheel by which the emery wheel is adjusted to the work, a dial being provided below the wheel by which movements of the cross-slide are indicated in .0005″, so that each graduation represents a difference of .001″ in the diameter of cylindrical work being ground. Graduations are provided by which the angle at which the wheel moves is indicated.

By reference to Figs. 1 and 3 the traversing mechanism will be understood. By the upper one of the two hand-wheels shown at the front of the machine the wheel can be traversed by hand, and at the center of this wheel is a knurled disk by which the automatic motion is brought into action. The smaller hand-wheel below, and at the left, is for varying the rate of this movement, and by turning this wheel while the machine is in motion the rate of the traversing movement can be increased or decreased at will, from the slowest ever required to ¼″ of movement of the wheel to one revolution of the work. In Fig. 1 the mechanism by which this is accomplished is shown, there being a friction disk, which, by a rack and pinion movement, is moved vertically across the face of the disk which drives it. At the lower extremity of the shaft on which the movable disk is fixed is a bevel pinion which drives two others as shown, and, of course, in opposite directions, these, by means of a double clutch, driving the worm shaft, which in turn drives the shaft which passes through the bed of the machine, and at its rear extremity carries the pinion which engages with the rack on the traversing platen, as shown by Fig. 3. The double clutch is thrown in either direction by means of the lever shown at the right of the worm gear in Fig. 1, the point at which the reversal of the motion takes place being altered at will by turning either one of the two knurled disks shown in front of the machine below the larger hand-wheel.

By means of friction disks at the countershaft, one of which is movable, the rotative speed of the work can also be varied at will by simply turning the rod shown at the left over the head-stock in Fig. 1, the range of speed being from 10 to 450 revolutions per minute. It is thus made possible to secure any desired proportion between the rotative speed of the work or the traversing speed of the

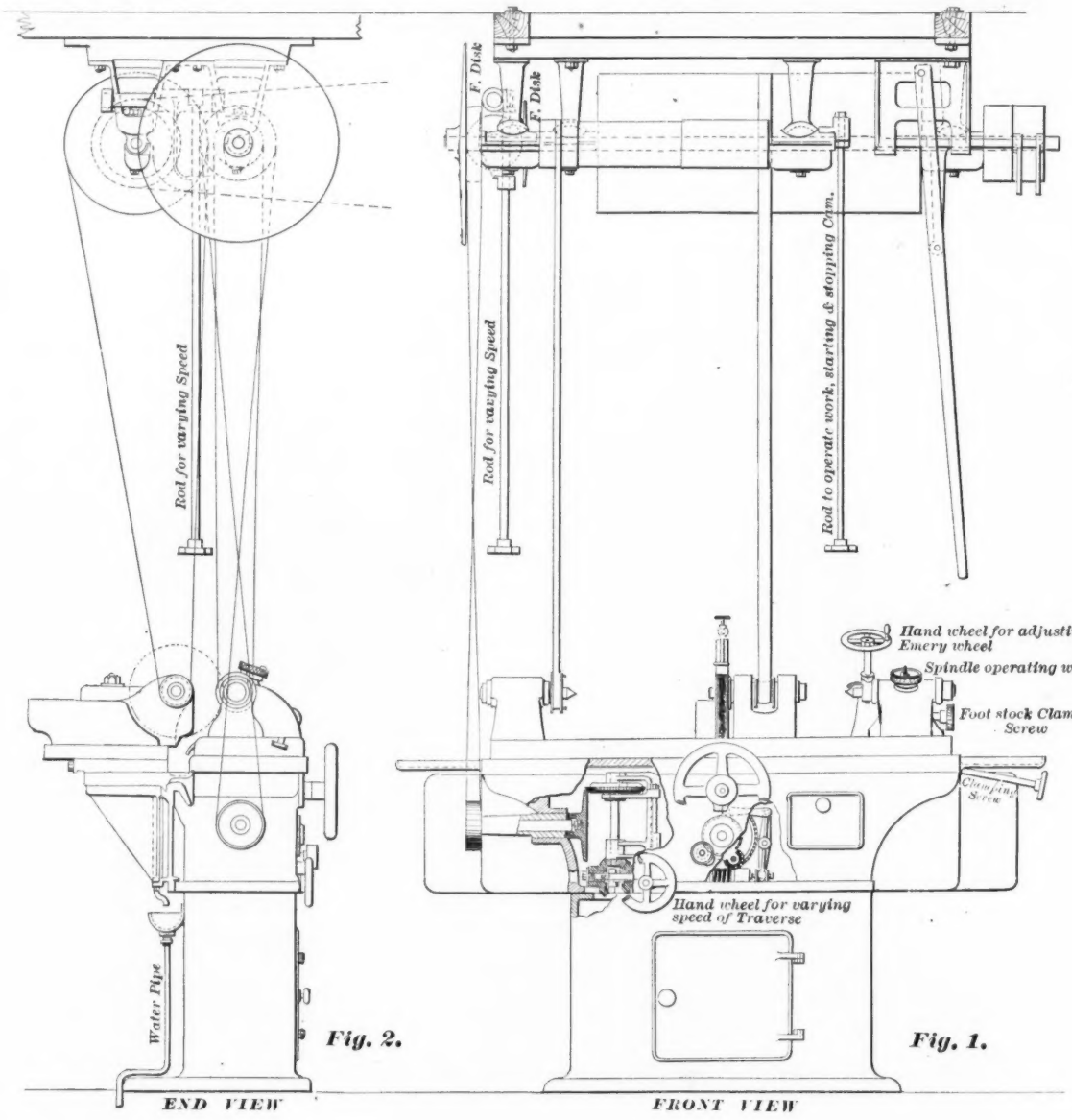


Fig. 2. Fig. 1.

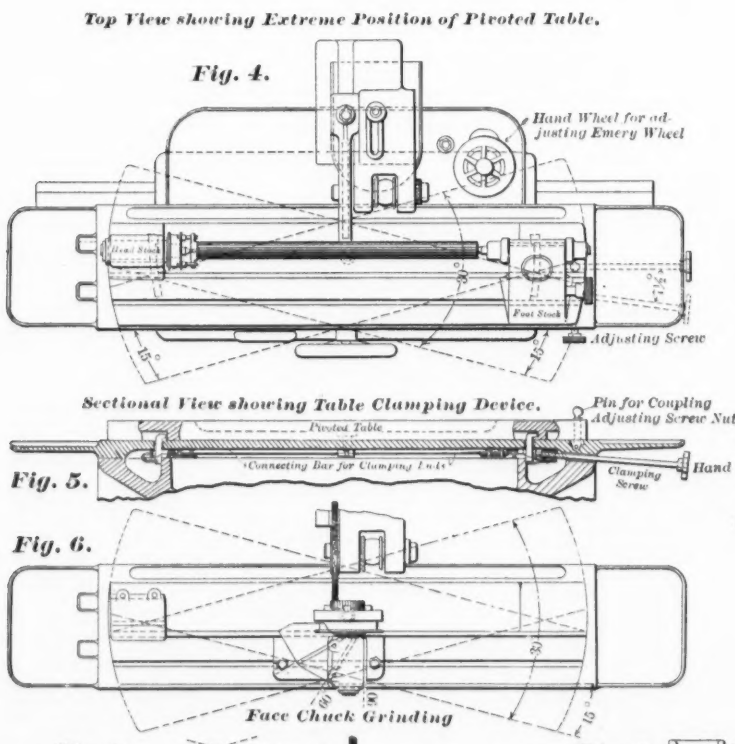


Fig. 4.

Fig. 5.

Fig. 6.

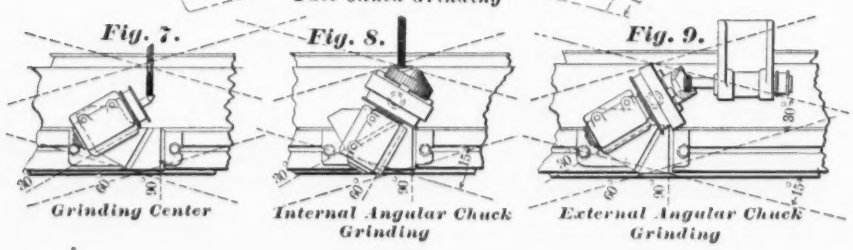
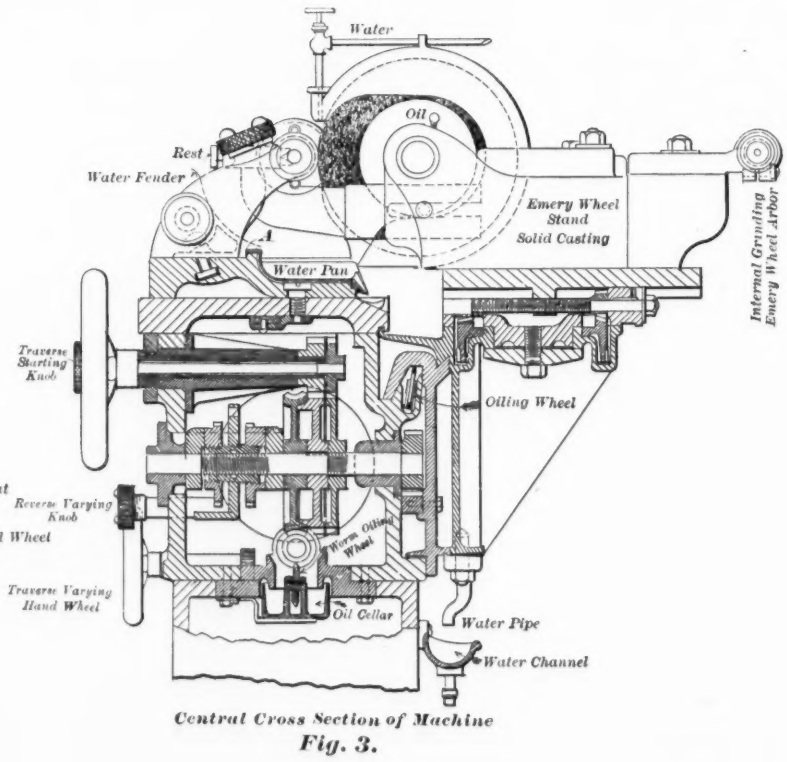
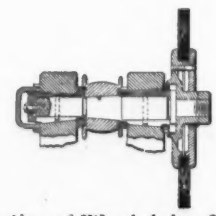


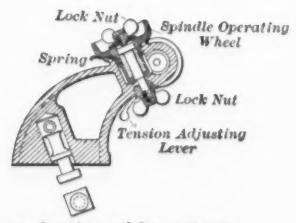
Fig. 7. Fig. 8. Fig. 9.



Central Cross Section of Machine
Fig. 3.



Section of Wheel Arbor Bearings
Fig. 10.



Cross Section of Foot Stock
Fig. 11.

Details of Universal Grinding Machine.—See Page 1.

wheel almost instantly and without stopping the machine. The rod at the right stops or starts the work, and at the same time stops or starts the traversing motion, but without affecting the motion of the wheel.

The head and foot-stock spindles, and the arbors for external and internal grinding, with their boxes, are of hardened steel ground true, and with provision for taking up wear. The head and foot stock spindles are hollow, for convenience in removing centers.

Self-oiling devices are provided for the worm gears and guide of traversing table, and pains have been taken generally to secure such a standard of workmanship as is demanded by a machine of this character The overhead works are self-contained, and are provided with self-oiling and self-adjusting boxes.

The capacity of the machine shown is for work 30″ long between centers, with 10″ normal swing, 12″ swing for face grinding. Its weight is about 2,700 pounds. Three other sizes are built, the largest of which will take in work 96″ long between centers, and swing 20″, and weighs about 8,000 pounds. Plain machines for grinding shafts, etc., are also made by the same builders, the Landis Brothers, Waynesboro, Franklin Co., Pa.

Saw Sharpener and Gummer.

The illustration on this page is of a new grinder for sharpening saws by the use of the emery wheel, recently brought out by the Appleton Mfg. Co., of 30th and Thompson streets, Philadelphia.

As shown, it resembles an ordinary emery grinder, and where provided with a wheel at each end of the spindle can be used as such, in addition to its use as a saw grinder, the latter feature being in the nature of an attachment, shown at the right in the cut, an inspection of which will show that it is so arranged that the saw can be held in any position with regard to the wheel. It is mounted on a stud, and centered by a conical collar, the stud being fixed to a plate which can be moved to or from the wheel by hand against a stop which limits its motion. Near the wheel is a substantial rest which supports the saw, and is adjustable to the gullet. In operation the knob is grasped, and the saw carried forward until arrested by the stop, when it is turned for the next tooth. The adjustability of the device makes it useful for either rip or cross-cut saws, and they can be ground in any desired shape with the certainty that each tooth will be just like every other one. The machine is furnished without the extra wheel and rest seen at the left, when desired, and it is to be used for saw grinding only. The size shown is for saws up to 24″ diameter, and uses wheels 1″x10″.

The new Danish infantry rifle, recently adopted, is a repeater having a caliber of 8 millimeters, a length of 133 centimeters, and a weight of 9.3 English pounds. The barrel is of compressed steel, 84 centimeters long, encased in a thin steel jacket, screwed fast to the barrel proper at the back end, so as to permit expansion and contraction of the barrel. This rifle is said to compare favorably with any in use.

Modern Development of the Steam Engine.

BY HARRIS TABOR.

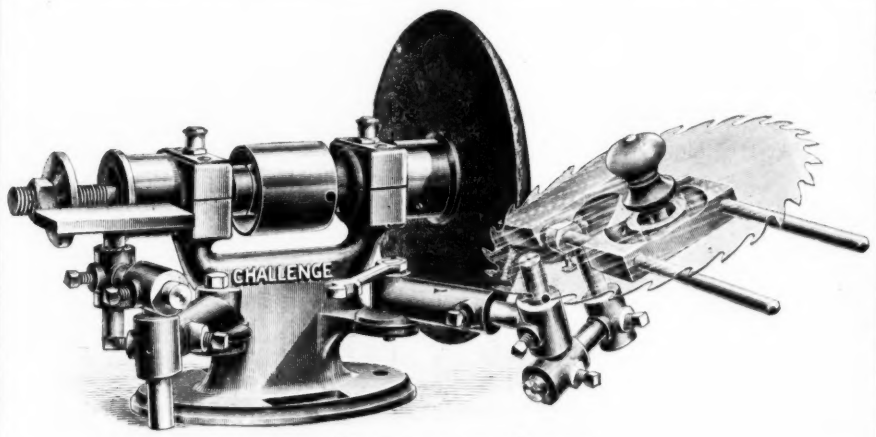
FIRST PAPER.

The steam engine has a fascination for people, even those who are not connected with its production and use. Probably no exhibit in the Centennial Exposition of 1876 elicited the attention and admiration so generously given to the Corliss machine that supplied motion to the mechanical products of the world. The great monster, with almost human intelligence in its movements, appealed to our love for power, and we applauded with a will.

When James Watt announced to his sovereign, "I have what your Majesty wants—power," the steam engine was crowned king; it has held royal sway in the mechanical world since, and until a Westinghouse or an Edison shall give us the subtle electric fluid direct from coal, its sovereignty cannot be questioned. Since all of us who love to see the wheels go round have an interest in the great prime mover that actuates them, a bit of gossip touching its changes and development during the past few years may be of interest, and I am tempted to indulge, if I may be assured that the readers of the AMERICAN MACHINIST will kindly accord their patience.

The struggle of Newcomen and Watt, and the story of the lazy boy who connected a cord from the beam of the engine to the lever of the valve, that he might leave his work of admitting steam to the cylinder, and play with his associates, is familiar to us all. We also know that the lazy boy's device was the germ from which sprang the multitude of valve gears in use to-day. Was there invention on the boy's part? Perhaps; at least there was discovery; but the boy, as in many other instances, had no knowledge of the great commercial value that lay in the application of his simple cord—instinct did the work, without reason to guide the boy, and it remained for Watt to add this device, modified, to his wonderful work in developing the steam engine. But we do not wish to go into the details of the origin and early growth of the steam engine. It is of its latter day changes and commercial growth we would write.

The present era of the steam engine began with Geo. H. Corliss. If, as some old philosopher once said, a man who makes two



SAW SHARPENER AND GUMMER.

blades of grass grow where one grew before, is a public benefactor, surely one who makes one pound of coal do the work of three is a greater one. Corliss, gauged by this standard, is one of the world's greatest benefactors. Few men ripen at the right time. Mr. Corliss did. If the conditions governing the introduction and sale of his engines had been made to his order, they could not have been more to his liking. Everything seconded his efforts, which were intelligent and well directed. His location, in the heart of the cotton-mill district, and remote from water power, was an important factor in the problem of his success. If his shops had been located in the coal fields of Pennsylvania, where coal had only a nominal value, the Corliss engine might have been twenty years later in securing its wonderful foothold on the market. The man who can command success under favorable auspices may fail under adverse ones; but Mr. Corliss was a man of wonderful resource and business sagacity; no matter how unfavorable his surroundings, success was bound to follow such intelligent work, in time. We know the type of engine in common use at the time Mr. Corliss came into the field. Chordal touched upon it when he described the Ethiopian boring a cylinder with a grate bar; and again, when the stick of cord wood was thrown under the connecting rod as an assistant to a leaky throttle when shutting down was necessary. Perhaps the New England engine was better—certainly in better repair—but at best it was uneconomical, and was a type nearly obsolete to-day, except in localities where coal is cheap.

Cotton-mills had multiplied all over New England; competition was sharp, and coal bills, where steam was necessary, were enormous. A fair dividend on the capital stock was wasted in coal. What an opportunity for a good economical engine!

When Mr. Corliss put intelligence in his valve gear; when he coupled the engine governor with the factory purse strings, and made it close the purse the instant enough steam had gone into the cylinder to complete the stroke with the most economical ratio of expansion, he touched the New England mill owners to the extent of gaining their interest; when he went still farther, and offered to put in engines for nothing, or, rather, without cost to the mill (he to take his pay from the coal saved), the fight was won, the reputation of Geo. H. Corliss as a great engineer established, and a new type of engine given to the world. From the time of its introduction it has steadily grown in favor, until it is now the standard engine of the world for large sizes.

When we speak of the Corliss engine we mean all engines of its class, *i. e.*, engines with releasing valve gear, controlled by the governor.

Since the Corliss engine became public property by reason of the expiration of its patents, it has undergone many modifications, but never to the extent of eliminating the finger-marks of its great inventor. The crab claw, or its equivalent, the tripping device under control of the governor, and the dash pot are always a part of the combination. In some cases the wrist-plate is dispensed with, but rarely; this is also true of the valves, plain gridiron sometimes being substituted for the cylindrical with quite as good results. In its early days this engine had a weakness which later builders have corrected.

We remember the arguments of its competitors, that its valves were not durable; that they soon leaked, etc. This charge was not without foundation. Originally the travel given Corliss valves was much less than at present; this compelled a small lap when the valve was closed; in time this narrow surface became abraded to the extent that leakage followed. Time and experience are necessary to education, and proved so in this case.

The later builders naturally studied defects, and worked to overcome them. Eccentrics with greater throw were used and the travel multiplied until the valves had an abundance of lap, and a very quick opening. We hear nothing now of leaky valves in the Corliss system. It is hard for one manufacturer to take up the product of another shop without leaving his imprint somewhere; generally the change is embodied in a patent. This disposition is so strong that changes are sometimes introduced that are questionable, to say the least. The Corliss engine has not escaped carving in its later life. Now and then we find a manufacturer who is content to let his improvements end with a hyphen between his name and Corliss, but generally many details are altered.

We find most evidence of change in the crab claw, or steam hook—the shape has been changed with a view to relieving the governor of shock and friction when tripping, and usually with good results; rollers have been used for this purpose also. These changes have lightened the duty on the governor, and have given much better regulation. The main changes and improvements, however, have been in the line of better workmanship, and a better proportion of parts. This tendency has been hastened by the high-speed advocates, who have compelled the slower-moving engines to quicken their pace. In its early days the objection to complication of parts in the valve connections was raised, but as the engines ran year after year without derangement, we became accustomed to it, and learned that there was not complication of parts; only multiplication of parts.

We rarely see a piece of machinery that has been so carefully thought out and worked out; every detail shows evidence of study and skill; from beginning to end we see the trace of the master mind and hand. Its valve gear is a marvel of ingenuity and skill. Some writer likened its action to the human hand, as it reaches out to grasp the valve lever, holding until the proper time, then letting go; sometimes holding on a little longer as the load demands, and again releasing when the piston has scarcely started on its stroke. The simile of the human hand should have been carried farther, and included the brain, for there is evidence of intelligence in every movement of the Corliss valve gear.

First American Tin-mill.

The mill of the Glendale Tin Mining Company is the first tin-mill established in the United States, and from it are now being put out the first fruits of the Dakota tin mines. The mill is located on Iron Creek, about twenty-two miles southwest of Rapid City, at the foot of the mountain in which the mines are situated. The mill proper measures 50 feet in width by 100 feet in depth, and is divided into three stories. It is unique in plan, compact and convenient, well built in all particulars, and protected from all danger of fire by a system of water pipes, and by having roofs, etc., covered by a thick asbestos coating.

Either steam or water power may be used for running the machinery. The steam equipment consists of two 100 horse-power boilers and a 100 horse-power high-speed engine. The water-power equipment consists of a flume 20x25 inches in section, bringing the water from a dam on Iron Creek, one and one-quarter miles distant from the mill, giving a head of 100 feet pressure at the wheel. About 500 miners' inches of water are supplied to the turbine wheel, which was manufactured by Craig, Ridgeway & Co., of Coatsville, Pa. The water power will be used except during the cold snaps in winter, the engines being placed in the mill as reserve power in case of accidents.

The ore is hoisted from the main shaft and dumped first into an ore bin of 200 tons capacity, located high up the mountain over the mill. From this bin it is conveyed to the mill by a wire-rope bucket tramway, the loads going down the hill to the mill, hauling the empty buckets back to the mine. The ore buckets mechanically deliver their contents into a 175 ton ore bin above and back of the mill. The large lumps of ore are crushed first by a Gates crusher, then passed through a drier to a set of Gates improved Cornish rolls; thence elevated to a set of rotary sizing sieves. From the sieves the finer sizes are conveyed to a set of Paradox concentrating tables, and the coarser sizes to common Hartz jigs. The screens, jigs and concentrators separate completely all the mica, quartz and feldspar, leaving clean concentrates of cassiterite, or oxide of tin, ready to be smelted into tin bar. The concentrates are for the present being shipped to Chicago to be smelted, but it is the intention of the company to erect at once a smelting plant in the hills. The first shipment of concentrates to Chicago yielded 65 per cent. of metallic tin, and the second shipment 68 per cent., and it is expected that with more practice they will yield over 70 per cent.

The main vein measures from 28 to 32 feet in width at the outcrop, and over 40 feet in the lower working. There is no doubt as to the true fissure character of the vein, as it cuts the slates at nearly right angles, and has well defined polished walls with a thick clay gangue or cleavage. The vein stuff is prin-

cipally albite (white feldspar), with here and there white glassy quartz. The black crystals of tin oxide are disseminated all through the vein material, varying in size from crystals weighing an ounce or more to those as fine as grains of pepper. Assays and tests from the different workings give an average of over 3 per cent. metallic tin, while picked or specimen rock is often blasted that will yield over 30 per cent. of the white metal. With these large bodies of ore and the excellent facilities for mining cheaply, there is no question that the present mill, with a capacity for crushing and concentrating 100 tons of ore per day of twenty-four hours, will soon be supplemented by a still larger mill.—*Rapid City* (Dakota) *Republican.*

Some Principles in Spiral and Skew Gears Learned in a Machine Shop.

By Jarno.

Some interesting principles can be noted in a train of involute spiral gears, when each gear has the diameter of the pitch circle equal to the diameter of the base circle of the involute, and has the lead or pitch of the spiral equal to the circumference of the base circle.

The Brown & Sharpe Mfg. Co. has, at my suggestion, made several gears of this class,

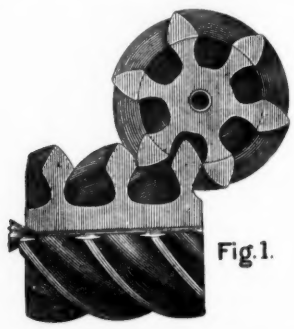


Fig. 1.

and has kindly placed them at my disposal, and given me the privilege of publishing an account of the experiments.

These experiments show conclusively that several writers of high standing have made mistakes as to the principles of spiral and skew gears, and that future editions of their publications must be corrected. Under "Odontics" in the American Machinist, Mr. Geo. B. Grant notices some of these mistakes. In this paper I will not give a detail of the erroneous assertions of other writers, but will speak mostly of the things learned by experiment as a machinist. The gears are quite expensive; the cost of the few pounds of cast-iron from which the cuts are made runs well up into the hundreds. It was somewhat a matter of experiment, to know just what to make.

Every gear in the cuts has six teeth. Fig. 1 shows two gears in mesh. The axis of the upper one is perpendicular to the plane of the paper. As in all cuts, the involute begins at the pitch circle, the base circle and the pitch circle being the same. The upper part of the lower gear is in axial section. The flanks of the teeth of all the gears are of no special shape, being merely cut away to clear the faces of engaging teeth.

In Fig. 2 the teeth are cut away at the pitch circle, making the flanks, as it were, reach outside of the pitch circle.

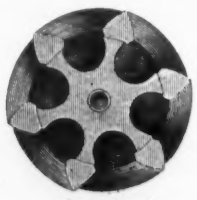


Fig. 2.

In Fig. 3 two gears are in mesh, each gear extending on both sides of the common perpendicular to the axes, or on both sides of the gorge circles.

Fig. 4 is another view of two gears in mesh, as in Fig. 1. In both Figs. 1 and 4 each gear is upon only one side of the common perpendicular to the axes.

Fig. 5 shows the shape of the teeth when sectioned by a plane tangent to the base circle.

Fig. 6 shows a way of cutting the teeth. A planing tool moves in a straight path, perpendicular to the plane of the paper, while the gear blank is held and moved, in the usual way, by the spiral mechanism of a universal milling machine, the mechanism

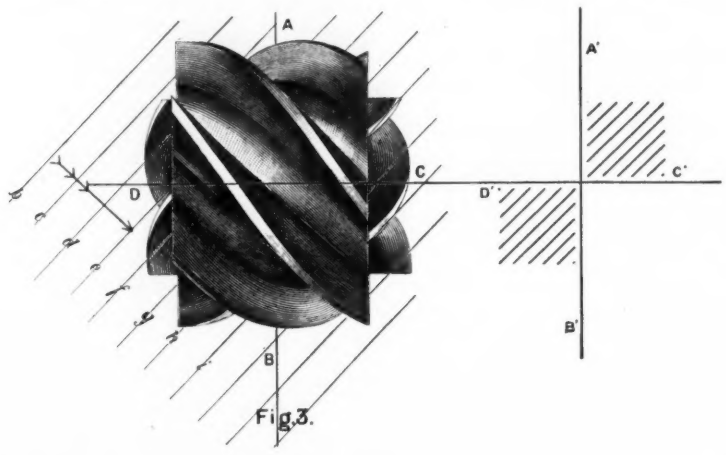


Fig. 3.

being mounted in a shaper. This method of cutting spiral gears has been referred to in the American Machinist. The tool has straight parallel sides which form the teeth to the involute, the reason of which can be understood by an inspection of the cut. The end of the tool cuts the flanks of the teeth. So far as I have gone, the shape of the end of the tool has been a matter of cut and try. In Fig. 6 the tool had straight tapering sides, from the pitch line to the end, and had a square end. Afterward it was learned that a round end tool will cut the flanks without making them so weak at the roots.

In Fig. 7 is another way in which the teeth can be cut wholly in the milling machine, by the long mill. The principle of this way is the same as cutting by the parallel sides of the tool, Fig. 6. In Fig. 7 the flanks have to be finished with another cutter.

The width of the tool, Fig. 6, and the diameter of the mill, Fig. 7, may be somewhat less than half the normal pitch of the teeth. It is well not to attempt to cut exact to thickness, but to finish first one side of the

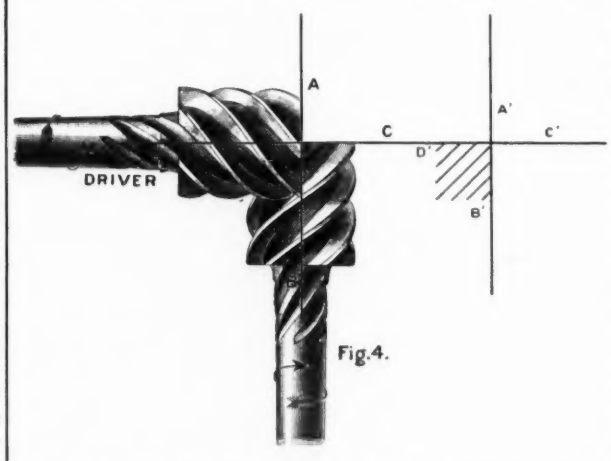


Fig. 4.

tooth and then the other, though theoretically the width of the cut of the tool can be half the normal pitch.

1. By this method of cutting the teeth they are made involute in a plane perpendicular to the axis, as seen in the upper gear of Fig. 1.

2. The elements of the teeth are straight lines. Each tooth element is in a plane tangent to the base cylinder, and makes an angle of forty-five degrees with the line of tangency. In shop language it is convenient to speak of the angle that the spiral makes with the axis, though strictly a spiral line does not meet the axis. Each tooth element extends in only one direction from the line of tangency of its plane on the base cylinder; on the other side of the line of tangency of the plane a tooth rounds away from the continuation of its tangent. This combined straight and curved character is seen in the gear, Fig. 5, which is sectioned in a plane tangent to the base cylinder. The same character can also be seen in Fig. 7, the lines a, b, c— — —l being in the tangent plane. For example, a tooth fits the line e on the left of $A\ B$ and rounds away from the line on the right of $A\ B$. The other side of the same tooth rounds away from the line f on the left of $A\ B$ and fits it on the right. The same alternate straight and curved character is shown in Fig. 5.

3. Two involute spiral gears exactly alike will run together with constant relative angular velocity, under certain limitations. When the involute tooth faces begin at the involute base cylinders, as in the upper gear, Fig. 1, each gear must be on only one side of the common perpendicular to the two axes, or, what is the same thing, the gears must end at the gorge circles; the base cylinders must be tangent; the gears must also be in a position as in Fig. 4, which will bring a straight line element of one tooth to bear parallel against a straight line element of an engaging tooth. In this position each gear can drive the other in only one direction, with unvarying relative angular velocity. If the gear D drives it must turn in the direction of its arrow. If B drives it must turn contrary to its arrow. The same position of gears is shown in Fig. 1, in which, if the upper gear drives, its upper part must move to the right, and, if the lower gear drives, its under side must come toward the reader. In Fig. 4 D drives, turning in the direction of its arrow.

4. In Fig. 4 the two base cylinders are tangent to a common plane, the lines of tangency to the plane being represented by $A\ B$ and $D\ C$. These lines are reproduced at $A'\ B'$ and $D'\ C'$. The lines of driving contact between engaging teeth are in the angular space between the lines D and B, as indicated between D' and B', being represented in a few positions. The first driving contact is on the line $D\ C$. The length of the contact becomes longer until it reaches the common point of $A\ B$ and $D\ C$; after the contact passes this point it becomes shorter until it ends in a point on $A\ B$. The different lengths of contact are indicated by lines between D' and B'. A few contact positions are also indicated between D and B, Fig. 5, one line coming on the edge of a tooth section.

5. These correct lines of contact between

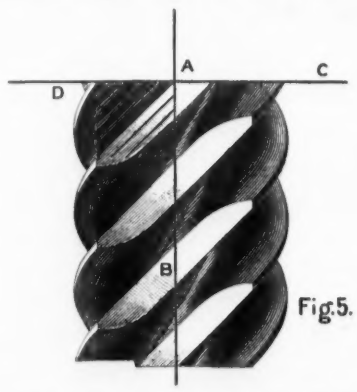


Fig. 5.

the teeth are in the common plane that is tangent to the two base circles, or cylinders.

6. The axial direction of the push of the teeth of a driving gear is toward its own gorge circle.

7. The faces of the teeth of one gear bear upon the faces of the engaging teeth in the other gear. This face-to-face action of the engaging teeth cannot be in external spur gears.

8. Spiral gears to be practical should be so that each gear can drive the other in either direction. To do this we would have each gear placed so as to extend on both sides of its gorge circle, or the common perpendicular to the two axes, as in Fig. 3. When so placed with their base cylinders tangent there is an interference. The common plane is represented at $A'\ B', D'\ C'$. The correct action is between A' and C' and between D' and B'. Between A' and D' and between B' and C' there is an interference. The reason for this interference may be understood by reference to Fig. 1. Let the upper gear be moved to the left, and points in its teeth will generate curves that come within the teeth in the lower gear, and in consequence these points interfere. The remedy for this is to cut away the interfering part of each gear, which is near the pitch cylinder. The gear, Fig. 2, is cut away at the tooth faces near the pitch cylinder. Two gears exactly like Fig. 2 will run correctly together, as in Fig. 3. So far as I have gone

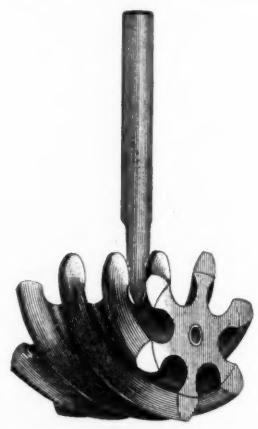


Fig. 6.

the amount to cut away has been a matter of trial. In so cutting we sacrifice a part of the correct contact near the lines $A'\ B'$ and $D'\ C'$, as shown in the lines of contact not reaching $A'\ B'$ and $D'\ C'$.

9. Skew gear teeth do not vanish at the gorge circles when the interference is remedied as in the foregoing.

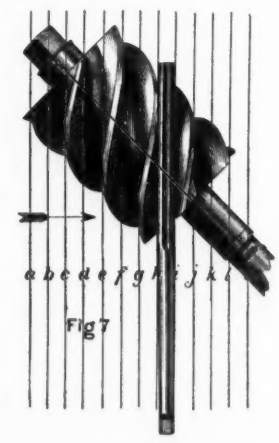


Fig. 7.

10. The gears in the cuts all have right-hand spirals, but the same general principles are involved in left-hand spiral gears. I have experimented with twelve-tooth spiral gears made on the same principle as those in the cuts. The twelve-tooth gears ran correctly with each other and with the six-tooth gears. They interfere when run as in Fig. 3, but I think that less will have to be cut away to remedy the interference than in the six-tooth gears. It would be interesting to make experiments with larger spiral gears, to learn the law of interferences.

Another interesting class of experiments would be with gears having different angles of spirals.

We find the following joke on the Scotchmen going round, but are unable to give its origin:

A Scotchman, who had been employed nearly all his life in the building of railways in the Highlands of Scotland, came to the

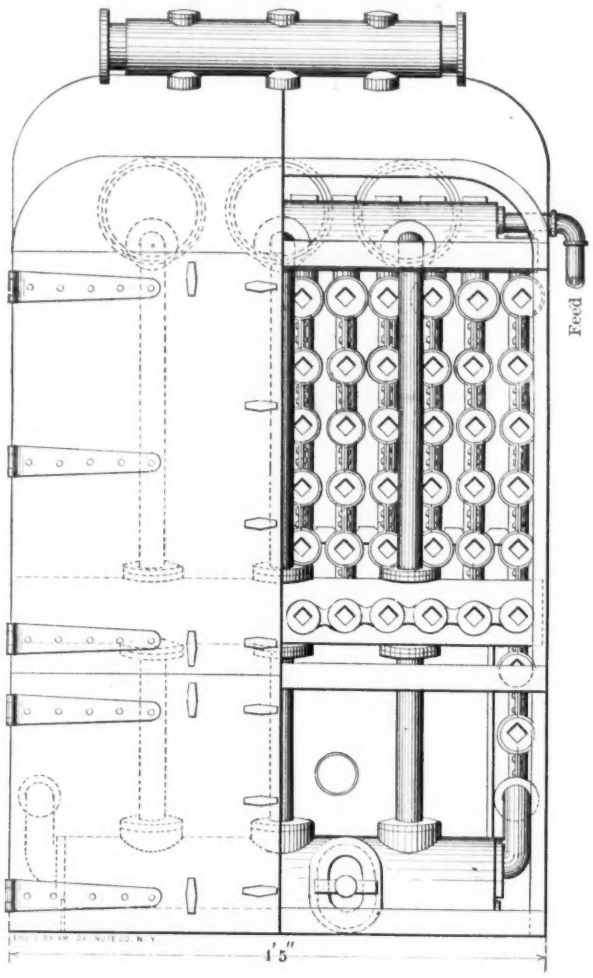
United States in his last years, and settled on the plains of the far West. Soon after his arrival a project came up in his new home for the construction of a railroad through the district, and the Scotchman was applied to, as a man of experience in such matters. "Hoot, mon!" said he to the spokesman of the scheme, "ye canna build a ra'lway across this kentry!" "Why not, Mr. Ferguson?" "Why not?" he repeated, with an air of settling the whole matter. "Why not? And dinna ye see the kentry's as flat as a flure, and you have naw place whatever to run your toonnels through!"

Do not commit the common blunder of thinking that there is some special virtue in "beginning at the foot of the ladder." On no subject is there more tiresome twaddle talked. The office boy in a bank stands the poorest chance of any one in the concern of becoming its president, unless favored by very unusual ability and extraordinary mortality among his superiors. There may be plenty of room at the top, but there is a fellow with a club on every landing, and if you have to enter by the basement door there is simply another chance of your being knocked in the head.—*Electrical World.*

The Corrugated Multiple Safety Steam Generator.

The title of the generator is explained by its construction, which marks a new departure in boiler making. Each section is a generator in itself, and is removable, and any capacity can be obtained by multiplying and coupling the sections. Each section, except the two outer ones, is made of one plate of metal, corrugated in such a manner that, when folded on itself and riveted together, it forms a series of manifolds and tubes. It is, in fact, what seems to be an anomaly—a tubular generator without tubes. This construction avoids the joints, and also the leakage that is liable to occur in the usual construction of tubular generators.

The sections are made of No. 9 B. G. mild steel, the stay rivets are ⅝″ diameter, and spaced 3″x6″, and 3″x 1½″ apart. Ferrules are fitted into the ends of the manifolds, and may be either riveted or welded in place. The ends of the manifold not used for connecting the sections together are closed by plugs. The top manifold of each section is 3¼″ diameter, the other manifolds are 3″ diameter. The connecting tubes are 1¼″ diameter.



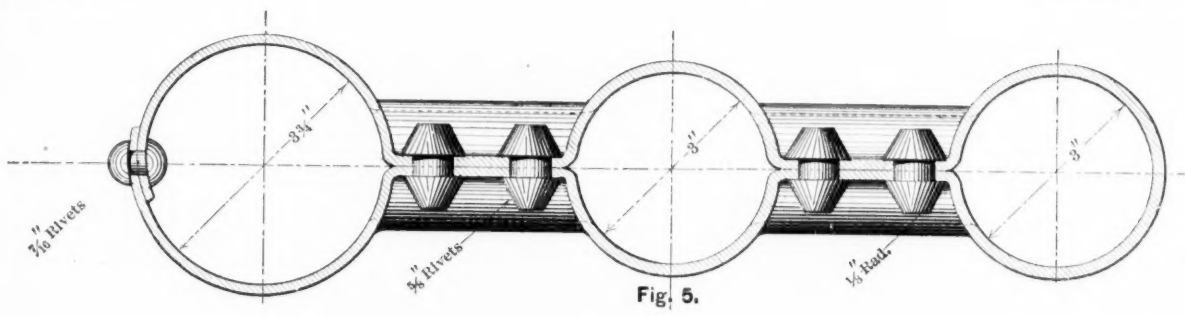


Fig. 5.

Three drums, 10″ diameter, are connected by manifolds, with the front and rear ends of each top manifold of section. The water, in circulating, passes through these drums from the front to the rear of the generator; they perform the functions of both separators and steam drums. The feed pipe passes into and along the rear manifold that connects the drums with the sections, and distributes the feed through the circulating water.

The bottoms of the two outside sections not being exposed to the direct action of the fire, are each made of two plates riveted together in the center of the top and bottom manifolds. A manifold connects with the rear end of each bottom manifold of inside sections, and also connects with the two outside sections, thus forming a free communication between the sections; connecting pipes join this manifold with the mud drum.

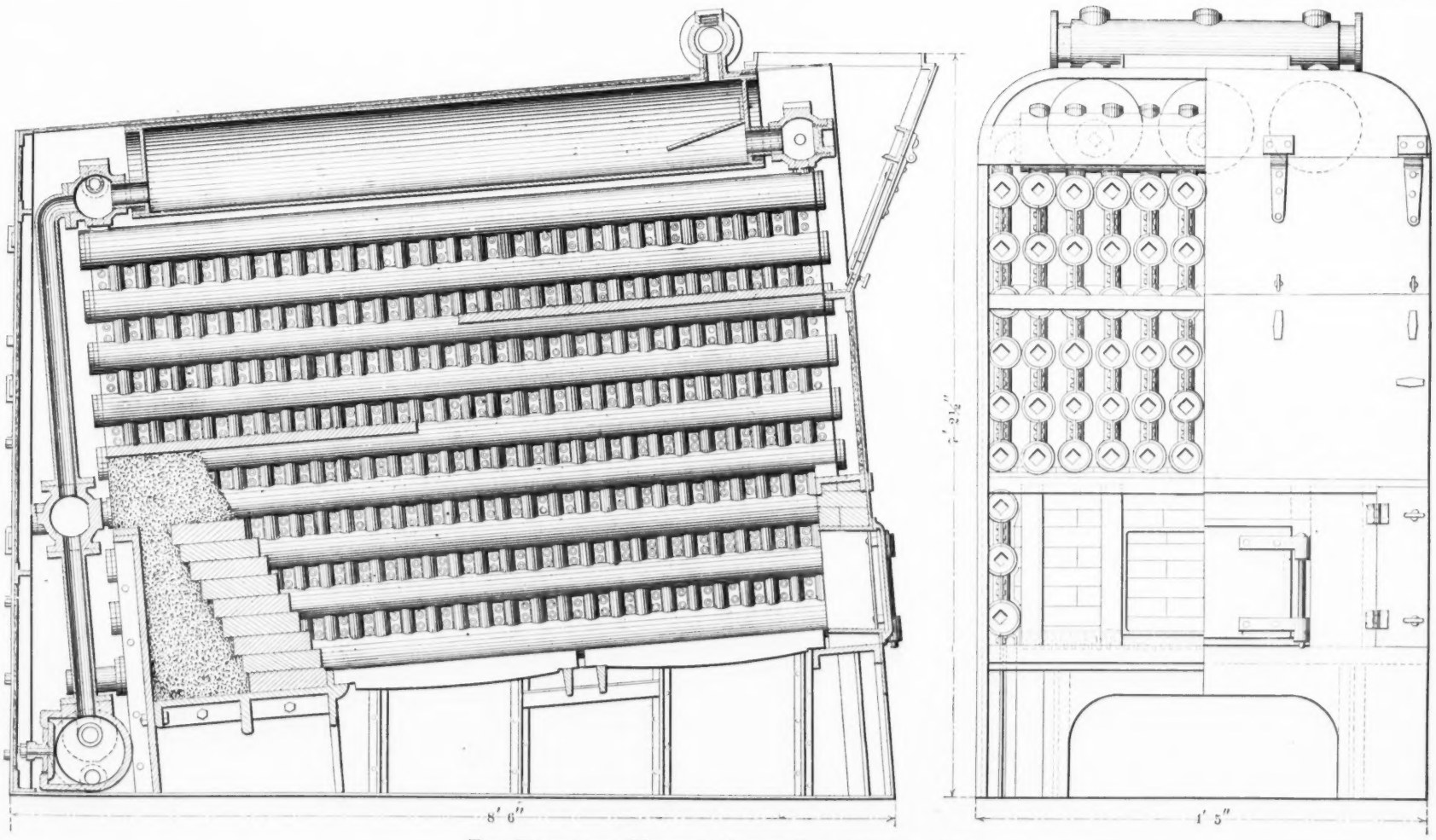
The rear of the furnace is closed with firebrick or other refractory material. The housing is made of wrought-iron plate, strengthened with angle and channel bars.

The outside dimensions of the generator are 8′ 6″ long, 4′ 5″ wide, and 7′ 2½″ high. It has 590 square feet of heating surface, 16½ square feet of grate and a draught area of 2¼ square feet. The weight, empty, is 13,100 lbs., and with water 15,200 lbs. It is rated at 50 horse-power. The generator being self-contained, and its form entailing little lost space, makes it well adapted to marine purposes. Fig. 5 shows the manner in which the sections are riveted together.

When flat surfaces, stayed in the usual manner, are subjected to a rupturing stress, the effect is first a bulging of the plate between the stays, accompanied by an enlargement of the holes around the stays, and finally the heads of the stays are pulled through the plate.

In the corrugated system, the effect of the stress is to increase the diameter of the tubes and manifolds; this tendency is opposed by the resistance of the metal to elongation, and the result is a square pull on the stay bolts. A stayed surface on the corrugated principle is stronger than one stayed in the usual manner, for the foregoing reasons.

The construction of the generator admits of a free natural circulation of the water, and of a short passage of the steam to the steam drum, two important factors in the rapid and economical generation of steam. An experimental boiler, constructed on this principle, has proved, we are informed, to be an excellent generator, steaming rapidly, and delivering dry steam at 200 lbs. pressure. Each section, before being connected, was sub-



The Corrugated Multiple Safety Steam Generator.

jected to a cold water pressure of 600 lbs. per square inch, without showing any sign of weakness or leakage.

The inventor is Mr. I. McKim Chase, Washington, D. C., and associated with him is Mr. George W. Wells, 119 Broadway, N. Y.

LETTERS FROM PRACTICAL MEN.

Bearing Surface in Proportion to Wear.

Editor American Machinist:

There is one point in relation to the question of the proportion of bearing surface to wear, which, I believe, has not been touched upon yet, and which, it seems to me, greatly complicates the problem of securing the proper proportions for any given case, by cutting away a portion of the surface as proposed by Prof. Sweet. How is it to be determined just where the most wear will take place in any given machine unless it is known just what it is to be used for?

It is very true that most lathe shears, for instance, are worn most near the head-stock, but there are exceptions to this rule I have known lathes to be used mainly for turning short lengths at the end of long lengths of shafting, bringing the wear mostly near the other end of the bed. In another shop in which I worked at one time there were some lathes which, so far as I know, were used exclusively for turning shafts of somewhat complicated form, that were always supported at the middle by the steady-rest, so that the shears were never used next the head-stock except when centers were to be turned or something of that kind. The length of bed and the length of the shafts happened in this case to be so proportioned to each other that the wear was confined almost entirely to the middle of the bed.

I have known planers in which much the same thing happened, both with regard to the wear on the cross-rail and that on the platen slides. There are men who use the universal milling machine with the spiral head always in one position, *i. e.*, at the end of the platen, and where the machine is used in this way the wear of the slide, and of the screw by which the feeding is done, is confined mainly to a length of about 12 inches from one end. But then there are other men who, having observed this tendency to wear in one place, correct it by using the head in different parts of the platen, and so distribute the wear as to greatly increase the length of time the machine can be run without overhauling. How can the builder of a tool tell how it is to be used, or for what purpose, and if he cannot tell this how is he to proportion the bearing surface to wear, the proportions of which he does not know? Now, Prof. Sweet set up his traversing machine, and used it for a while, and by that means determined just where most wear would come on that machine when doing his work, and could then proportion the bearing surfaces accordingly; but could he proportion them on the same machine for some other man's work? He probably could for the majority of other men, but how about the minority, who would be worse off than if nothing had been done in that line, because the chances would be that the bearing surfaces would be cut away most just where they wanted to use them most? This would seem to indicate that while cutting away might be all right for the man to do who was to use the machine, and knew just how he was going to use it until it was worn out, it would hardly do for the manufacturer of the machine.

T. A. PANDIE.

Critical Notes.

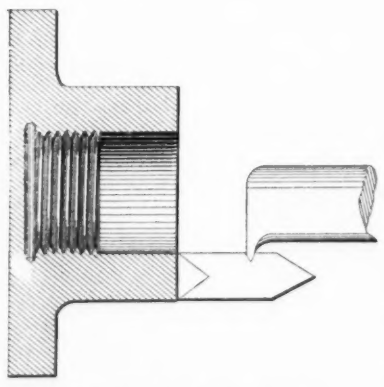
Editor American Machinist:

In the AMERICAN MACHINIST of August 7, Mr. P. H. Bullock refers to an engine having an indicator pipe on it, with a three-way cock in the center, as an example of a small continuous loss of steam, amounting to half a horse-power, and if the printer has not done him wrong I think the statement needs a little further consideration, or an explanation, before being fully accepted. The engine is given as having 4 feet stroke, and running 80 revolutions per minute, with an average mean effective pressure of 14 pounds. He then considers he pipe as a small cylinder, with .196+ square inch area, and makes it out half a horse-power going to waste. Let us see: 4 feet stroke makes 8 feet per revolution, and 80 revolutions make 640 feet per minute piston travel. .196 × 14 pounds M. E. P. = 2.744 pounds, which, × 640 feet, gives 1,646.16 foot-pounds, divided by 33,000 = about .05 H. P., which lacks quite considerable of half a horse-power.

This is, no doubt, a mistake in the calculation, and needs only to be mentioned to be corrected; but it is not correct to assume the mean effective pressure as a measure of the loss in the pipe, for the total steam possible to lose by the pipe is that due to condensation in it, and the cubical contents of it at terminal pressure. If the M. E. P. had been 56 pounds, then, according to Mr. B.'s plan of estimating, it would have been four times greater loss, which is obviously wrong, for a greater part of the 56 pounds would have been expended in doing useful work on the piston, and the loss would be the pipe full of steam at the terminal pressure. If the exhaust valves were set so as to compress steam up to nearly initial pressure, and cut-off took place early enough to make it exhaust at atmospheric pressure, then the only loss caused by the pipe would be that due to condensation in it, and the additional friction caused by the engine compressing the indicator pipe full of steam.

Mr. W. H. Harrison, in AMERICAN MACHINIST, August 7, referring to the use of the word calorimeter, says, "Thus Ericsson's hot air engine was called a caloric engine, the mystery connected with which enabled him to raise large sums of money from the credulous people of New York." Now, according to the statement of those who had an opportunity of knowing him best, it was one of the characteristics of Captain Ericsson's career that he was never identified with, or lent his name to any speculative schemes, but during his whole life was engaged in legitimate and honest mechanical enterprises and when it is remembered that the United States Government failed to fully recognize his ability, and pay him that which was justly due him, it is the least that could be expected of mechanics that they should appreciate his high qualities. I regret very much that there is a single mechanic in this land who should cast such a reflection on the character of one who did such eminent service to our country.

B. CRANK.



Some Kinks—Some Kicks.

Editor American Machinist:

Who has not been bothered when cutting inside threads in a difficult place by having the tool break or get dull when the thread is nearly finished?

When a piece is being cut something like the illustration, where the thread is in a deep recess, it is difficult to set a tool exactly in the thread after once it is changed. A man will sometimes try to get the gas, his head and the tool in a two-inch hole at the same time. I have tried this, and I believe it can't be done.

When I found a scheme for resetting a thread tool accurately, I was not slow in appropriating it. When setting a tool by the gauge in the usual way, have the nut locked in and the "back lash" out of the lathe, as though you were ready to commence cutting. When the tool is set right and screwed down, hold the gauge on the tool as shown, and turn the spindle till the gauge touches the face of work, then put a chalk mark to locate lead screw and spindle, as in "catching threads." Measure with a scale the distance from face of head-stock (or any other convenient place) to carriage, and make a note of it. If it becomes necessary to disturb the tool and readjust it, you can bring the screw and spindle to the same location as before, and bring the carriage to the right place by one measurement, lock in the nut, then run the lathe back and up to take out "back lash." Now with the gauge against face of work, set the tool to fit notch as before.

Some feel "shaky" about cutting a thread close to the bottom in a place where they can't see the point of tool. I have got a little scheme on this. When the tool is set correctly, and without the nut locked in, run into the hole until the tool bottoms. Measure from head-stock (or what might be most convenient) to the carriage, then run the carriage back a little, throw in the nut, and then turn the lathe until the carriage comes to the same position. It is best sometimes to feel by partly throwing out the nut, and moving the carriage ahead a little.

When you get the tool to just bottom, make a scratch on the tool by sighting across the face of work, and mark a chuck jaw, or something, so you can know the position of spindle. When cutting, keep one eye on the line on the tool, and stop the lathe when it is about one turn from face of work, then turn the spindle by hand till the marked chuck jaw comes to its position, and you are just right. This is the micrometer fashion. It is a good plan when the thread is finished, and the tool is at the bottom, to throw out the nut and chamfer the back end of thread with the thread tool.

When it is necessary to recess a piece in the lathe to a given depth, one way is to work first by guess, and then measure and see how much there is to come out, then take out some and measure again, and so on. A better way when the conditions will admit of it is this: Suppose it is necessary to recess a piece two inches deep. After the hole is roughed out, square up the bottom a little deeper than two inches, and with the tool in the same position as when cutting, bring the stop on ways (if there is nothing made for the purpose, a parallel clamped to the lathe bed will do), to touch the carriage and clamp; then run the carriage back until the two-inch plug just fits between the stop and carriage and square up face.

A good stop, fitted to the ways so as to clamp in any location, and an adjusting screw, is something which ought to be a part of every good engine lathe.

In a town where I once worked there was a shop which excited my curiosity to no small degree. There was nothing so very funny about this place, except that the windows were painted. I imagined there must be something very secret about what they were doing, as they were so very careful no outsiders should look in. I went around that shop several times one Sunday trying to find a place where the paint was scratched off, so as to get a look at what they were doing. I was not successful, and it was a year before I found out what those windows were painted for. When I found out that it was to keep their workmen from looking out, my interest and curiosity turned to disgust. The next move I shall expect to see from such people will be no windows, and a good healthy electric light plant.

It has not been my experience to see good workmen spending their time looking out of the windows, especially into a cow pasture. It has been my experience to see good workmen over-industrious. Sometimes they are so afraid they will not make good time on a job that they go off "half-cocked." If I had a man working for me who was so lazy and indifferent that he would spend a large part of his time looking out of the windows, I would advise him to work in some other place; I would not paint my windows for his convenience.

The same about the time of getting to work. I do not consider this a fine point, one that would be necessary to have a vernier plate on the hands of the clock for, but if I found a man making a practice of coming in late, I would talk to him about the conveniences of other places.

It is a good plan to have everything in and around a shop handy, clean, and pleasant. Keep the windows clean, and the shop light and pleasant, if you want to get good work and lots of it. I know of a railroad where, a few years ago, the grass was almost growing over the rails. The company got a new manager, a man who had quite a reputation as a grass annihilator, and the farmers along that line have not cut a good crop of hay off that road since. Under the new management the employes were wanted to live in a little desolate place where the shops were located. It was the most desolate place I ever saw. This desolate place is made into a park, and everything else has been so well managed, in a way of making things pleasant, that now I believe the people consider it a privilege to live there.

I noticed in the AMERICAN MACHINIST in January a letter from a large machine works, stating, among other things, that they employed 800 *hands*. Is this 400 men, or is it 800 one-armed men, or does it refer to men at all? We see in common use the word *head*, as applied to cattle and cabbage, but hands of men. This word is old, but the one who first applied it to mechanics did not show much respect for them. To be sure there is not much in a name, but where a name shows disrespect we ought not to use it.

Hands, as applied to mechanics, considers them to be tools. This is not true. I have never found any trouble with my hands; they were always big and strong enough, since I have been in the business, to do all I have had to do, but I have sometimes wished that I had a better head. A hand might pour oil or soda water on a milling arbor, or on the floor at the back of the machine, but a good head would certainly put it where the work was going on.

A MECHANIC.

[We fail to see any objection to the use of the word "hands," which shows that we do not all think alike. The word is comprehensive, including men, women, boys and girls, hence its employment often saves the use of several words. Its meaning is understood by every one, and, so far as we are aware, is never used in a disrespectful sense.]

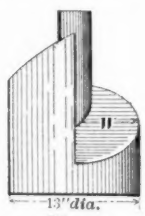


Fig. 2.

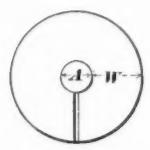


Fig. 1.

Laying Out Sheets for a Conveyor.

Editor American Machinist:

At the jobbing shop where I am employed, they had an order a short time ago for a few lengths of a sheet steel conveyor. The thickness was No. 10 B. W. G., diameter 13 inches; and 13-inch pitch with a 3-inch pipe center. These lengths were made in the following way:

The stock was cut into rings having the inner circumference *A*, Fig. 1, equal to the length of one turn of a 13-inch spiral around the circumference of a 3-inch pipe. These rings were then heated, and the outer edge stretched in a cast-iron die, Fig. 2, of the finished shape, and then riveted up to length.

I have never seen anything on this subject in print, and would like to hear of a better way from the readers of the AMERICAN MACHINIST. Can the stock be laid out to bend to shape without stretching?

JOHN T. GARDHAM.

Montreal, Canada.

For a London World's Fair.

It has been an open secret, since the tremendous success of the Paris Exhibition, that the idea of holding a great international exhibition in London, on as large or even a grander scale, has been entertained in influential quarters, and that a provisional committee of would-be guarantors and exhibitors, with Sir G. Hayter Chubb as president and Sir H. Trueman Wood and Mr. A. J. R. Trendell, C. M. G., as secretaries, has been quietly at work collecting information and estimating the chances of success. The proposal was to hold such an exhibition in 1893 or thereabout, and an admirable and comparatively inexpensive site—as to which

no clearer indication need be given—had been appropriated for the purpose in the mind's eye of the committee. But the Prince of Wales, who was, of course, consulted when matters were sufficiently ripe, and without whose countenance and support no exhibition could be successfully promoted, has expressed to the committee his opinion that it would not be expedient to hold such an exhibition in London until quite the end of the century. There is no doubt that his Royal Highness, with his great practical wisdom and keen insight in all matters of the kind, has rightly gauged the position of affairs, and has considered that the public is perhaps getting tired of the exhibition mania and has had enough of these gatherings, for the present at all events. There can be no question, however, that such a project—whenever it is realized—will have a widely beneficial effect on trade and commerce, and will give to the metropolis especially, and to all who live by London industries and upon London visitors, a well-deserved turn of prosperity. But a London exhibition must before all things be a success, and if there is greater likelihood, in the judgment of those best able to form an unbiased opinion, of its being more successful in 1899 or 1900 than in 1893, the only thing to be done is to wait, and to make good the time between this and then by increased preparations.—*London World.*

Undoubtedly the Prince of Wales has shown great practical wisdom and keen insight in advising the provisional committee to hold the London World's fair in 1900 instead of 1893. The Prince of Wales must also have known that Uncle Sam has a caveat for holding the World's fair in 1893, or thereabout, a fact which the provisional committee seems to have overlooked, or did not find out in quietly collecting information and estimating the chances of success. In the meantime Uncle Sam has been pushing the preliminary steps of holding the World's fair on this side of the Atlantic, and in his usual energetic way intends to show not only the progress which has been made in the arts, sciences, etc., but also the progress which can possibly be made in some years to come. Under these circumstances we cannot see what new things our English cousins can show in 1900, and therefore we would advise them to postpone their exhibition until the year 2000; the chances of success will then be certainly much greater; and, besides this, it will afford ample time for the sight-seers to overcome their surprise at Yankee ingenuity, and rest their dazzling eyes, which the brilliant affair in Chicago is sure to produce.

Practical Details of Blacksmithing.

By B. F. SPALDING.

CRITICAL TEMPERATURES OF STEEL—WHITE HEAT—BLUE HEAT—RESULT OF EXPERIMENTS—DANGER IN BOILER MAKING—IN SHIPBUILDING — "SETTING" TEMPERED WORK AT A BLUE HEAT—DISCOLORATION IN HARDENING CHECKS—BRIGHT CRACKS—SHEARING AT BLUE HEAT—CAUSE OF SCISSIBILITY.

It is generally acknowledged that there are several critical points in the heating of what London *Engineering* calls "that fickle metal, steel." A very dangerous temperature is just below the melting point, where, when the heat is rising, cohesion is destroyed and flow is not yet induced. It is at this point that steel castings, in cooling, have not as much strength as the sand in which they are cast, and hence pull asunder while shrinking. It is also at this temperature that the blacksmith finds that any jar is liable to produce cracks in bar steel.

There are other danger points peculiar to the chemical nature of various steels, and dependent upon the proportions of their constituents, but the one mentioned is of a general character, and belongs, in some degree, to all kinds of steel (and probably to metals generally).

By the exercise of only ordinary caution, this danger point can be easily avoided, unless there is a necessity of raising the heat sufficiently to make a weld, when some risk must be incurred; but by the use of fluxes, flow is speedily induced, and the range of danger limited. The risk of this temperature is so glaringly apparent that not to guard against it is gross carelessness. But there is another critical point in the temperature of steel, not as easily perceived as this; known by its darkness rather than by its glow, and that is the point which is just below a heat which shows red in the dark. At this point there appears to be another molecular change in the metal; for, if a hardened piece of steel is brought to this temperature, the changes produced in its internal structure are such as to give—as regards flexion, but not as regards impact—the greatest amount of elasticity.

It may also be received as a fact—established by the experience of a great many steel workers, whose judgment and veracity cannot be questioned without considerable assumption—that when steel, after slowly cooling—from a heat which has been sufficient to raise a thin scale—is quickly quenched when it reaches this point, it is in a condition termed "water-annealed," in which the carbon lies loosely in the graphitic form, the texture of the steel is open, and is in the best possible condition to be acted upon by filing.

In a paper read before the British Institute of Civil Engineers, the results were given of some three hundred and thirty experiments which had been made to ascertain the peculiar nature of the "blue heat" of iron and steel. The author, Mr. C. C. Stronmeyer, included in the term "blue heat" all those temperatures which produce discolorations (ranging from light straw to blue).

It was shown that, in most cases where iron or steel had failed in an unaccountable manner, from apparently inadequate causes, it had been subjected to bending or hammering while at a blue heat, or, as smiths and boiler makers termed it, a "black" heat. The experiments appeared to demonstrate that such treatment was very dangerous, that any treatment tending to produce a strain, at this heat, should be avoided, and that the idea that "taking the chill out" of boiler plates, by giving them such a heating, instead of being a measure of precaution, was quite the contrary. The limits of temperature thus designated were from where it was not quite hot enough to ignite the dust of wood, down to where it was just too hot to be touched with the hand, perhaps from 600° to 212° F.

Further investigation was suggested, to ascertain whether these phenomena were exhibited by every quality of steel, and whether duration of exposure to such temperatures alone would make the steel permanently brittle.

Mr. W. Denny, eminent as a Clyde shipbuilder, said, in a paper read some ten years ago, that the experience his firm had then had led them to look with confidence on steel as a material in shipbuilding, and with doubt on iron. He especially stated that the only danger they had in working steel was incurred by working it at a "black heat."

The special study of phenomena, which have long been noticed but not thoroughly investigated, will, if thoroughly pursued, lead to the formulation of rules, which will be accepted by the courts as authoritative in such cases as involve the question of good or bad workmanship; but there are a great many things which are to be taken into consideration before such a rule can be formulated as will give satisfaction to those who perform the labor, the measure of whose skill depends upon their varied individual experience. After a workman has obviously spoiled a few pieces by any particular mode of treatment, he will discontinue the incurrence of like risks, except at the express dictation of his employers, but he will know of a thousand exceptions to any fixed rule.

There are undoubtedly certain kinds of stress which may be put upon steel, while it is at the temperature mentioned, to which it is peculiarly vulnerable; but it is not evident that, under these thermal conditions, it then offers less resistance to all kinds of stress than it does when it is unheated. Bayonets are straightened at this heat. Where the process of hardening bayonets is carried on as a business, there is some attention paid to performing it in such a manner as will leave them as straight as any uniform treatment for this object, to which they could be subjected. With the utmost care to prevent it, however, they will still warp, more or less crooked. This has come to be accepted as the inevitable result. For this reason the principal exertions of the operator are directed, not so much to prevent the blades from warping, as to correcting the crooks thus acquired. This is done while they are at a temperature at which they will, by contact, ignite the dust of wood; or, in other words, when they are heated enough to draw them to a low spring temper. They are straightened by hammering, and the blows given them are not at all sparing in force. It would be better, indeed, not to strike them at all, than not to hit them hard enough to bend the blade beyond the limit of elasticity, and "set" it permanently to the proper shape. Practical experiment has demonstrated that thus straightening them, at this heat, is less hazardous than the effort to perform the operation when the heat is less, or normal.

In the description of the fabrication of small arms for the United States service, prepared under the direction of Lieutenant-Colonel Benton, Commandant at the Springfield Armory, the process of straightening a sword after hardening is thus given: "It is now very hard and brittle, and generally warped. It is therefore necessary to straighten and partially anneal, or temper it. To effect this, it is again heated; this time only to a blue heat. While thus heated it is soft, and can be straightened, which is done quickly." This does not close the subject, for we find again this statement: "By grinding, the blade is oftentimes bent, and partially annealed To correct these defects it is again heated to a blue heat, straightened quickly, and plunged into cold water, by which it is re-tempered."

Many people are unacquainted with the fact that steel of a spring temper may be treated so that it will lose much of its flexion elasticity, and will stay where it is put, and of the corresponding fact that this property may be restored to it by re-heating it, as the swords are treated. Many are possessed of new information when they learn that hardened steel, before it is re-heated in any degree, can be hammered and "set," and retain the "set," when it is subsequently drawn to any desired temper; but shoe knives are hardened in oil, and hammered straight easier, before the temper is started, than afterwards.

The correction of the setting of gun mainsprings has been a trade secret. In some manufactories, where a great many have been made which were submitted to the rigid inspection required by the Ordnance Department of the United States, the mainsprings, after being accurately "set" to the required form, while hot, have been subsequently re-heated to a degree which would have appeared to a careful steel worker, inexperienced in this particular art, to be altogether too high, and then hardened by quickly immersing them in the quenching medium. The almost white heat to which they were raised would have ruined them if they had been exposed to the air, but great care was taken to keep them from such exposure by heating with charcoal in a close furnace, and quenching them as soon as they were removed from it, getting them into the mixture of sperm oil, beeswax and tallow as quickly as possible. After the temper was drawn they were allowed to cool off, and were afterwards tested to ascertain whether they possessed the requisite stiffness and elasticity, and were straight when under strain. Corrections in these particulars were necessarily made while they were cold. They were sometimes subjected to treatment in effecting these which was more hazardous in appearance than in reality. Besides being filed to weaken stiff places, they were bent to stiffen weak ones. They were gripped in such a manner that they could be bent at any desired point, and then stressed beyond the limits of elasticity enough to give them a set. The bearings were not too far apart, and caution was observed not to produce too great a strain at any one point, but to distribute it at different points along the portion which required treatment.

Bayonets, swords, knives, or other articles requiring a spring temper, can be treated cold like the main-springs, but "setting" them while hot is not found to be particularly risky as far as the tenderness of steel at a blue heat is concerned, and is a straightforward, go ahead, efficient method of doing the work.

Of all the breaks in steel that I have ever seen which have been caused solely by the overstrain in hardening when no mechanical force had been exerted upon them, by far the large majority have exhibited discoloration of the fracture, which must be taken as evidence that the separation occurred at a time when the piece, which cracked, was at the temperature corresponding to the color of the fracture. I have found a milling machine cutter 4" diameter by 2" face lying in the morning in halves on the window-sill where I had placed it, newly hardened, the previous evening, and have discovered that it exhibited a clean, bright fracture without any discoloration whatever. I have finished a straight steel forging at a heat just below red, and laid it on the floor, and have found it broken afterwards without bearing any indication of having received mechanical injury, but with the severed surfaces bright and uncolored. Such occurrences may be accounted for on the supposition of internal strains, but whether they can be satisfactorily explained or not, the fact that they take place without leaving a blue streak behind them shows that there are natural causes which will produce breakage as well under other thermal conditions as at a blue heat.

At a blue heat steel is very susceptible to a shearing stress. It can then be cut with shearing dies to much better advantage than when it is cold, or when it shows red-hot by candle or daylight. When it is heated to a full spring temper it is sufficiently luminous to enable its outlines to be distinguished in the dark. These are not very exact terms, but they are to be understood as ordinarily applied. They are more practical than specifications of thermometric degrees which require the possession of a pyrometer; for the senses can take hold of them without instruments. I am not in possession of accurate information as to the exact degree of temperature at which steel is most susceptible to the shearing stress, but am of the opinion that it is between the first and second blue, and nearer the latter.

I have had occasion to cut many thousand pieces of ⅝" octagon steel with blows on shearing dies. It was of a nature which caused it to break badly when the attempt was made to cut it cold; and I found that less force was required to cut it at the temperature mentioned than when it was either hotter or colder. It is not any new freak in steel, either, not anything that has come about with the later processes of making steel, for I well remember when I was an apprentice of ascertaining the same fact as I swung the sledge day after day in the not phenomenally exhilarating occupation of cutting up stock with a hand shearing tool for cotton-mill spindles. It would have been a difficult task at that time to have convinced me that I was learning anything at that monotonous pound—pound; but I noticed then, and remember still, that when the bar was easily sheared the severed section quickly assumed a dark blue color, and that it cut harder when the surface of the section became of the greenish blue of a higher temperature, or exhibited the straw color of a lower one.

The common explanation of the sensitiveness of steel at this heat is plausible. It is that just below the point where steel will harden at recalescence, a molecular change of structure takes place, the steel and carbon particles fly apart, those of carbon, which were previously combined with the steel separate, and lie loosely in the graphitic form among the steel grains. The steel is not as tough as when it is hotter, nor as hard as when it is colder, and between these it is in the condition most easily sundered. Steel also, for like reasons, punches easily at this heat.

It is said that manufactured ice is sold in Macon, Ga., for twenty-five cents per hundred pounds.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
96 FULTON ST., NEW YORK.

PUBLISHED WEEKLY AT
96 Fulton Street, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
J. G. A. MEYER, } Associates.
FRED J. MILLER, }

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

Subscription.

$3.00 a year in advance, postage prepaid in the United States, Canada, and Mexico.
$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,
Publishers' Agents, New York.
The International News Company,
BREAM'S BLDG'S, Chancery Lane, LONDON, E. C., ENG., will receive subscriptions for the AMERICAN MACHINIST, at 16/6 per annum, postage paid.

DEALERS SUPPLIED BY

The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Buffalo News Co., Buffalo, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, N. Y.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N.Y.

NEW YORK, AUGUST 28, 1890.

CONTENTS.

	PAGE.
Key-seating Machine	1
Universal Grinding Machine	1, 2, 3
Saw Sharpener and Gummer	3
Modern Development of the Steam Engine. By Harris Tabor	3
First American Tin-mill	3, 4
Some Principles in Spiral and Skew Gears Learned in a Machine Shop. By Jarno	4
The Corrugated Multiple Safety Steam Generator	5, 6
Letters from Practical Men: Bearing Surface in Proportion to Wear. By T. A. Pandie—Critical Notes. By B. Crank—Some Kinks—Some Kicks. By A Mechanic—Laying Out Sheets for a Conveyor. By John F. Gardham	6
For a London World's Fair	6, 7
Practical Details of Blacksmithing. By B. F. Spalding	7
New Lines of Employment for Women	8
Book Knowledge	8
Literary Notes	8, 9
Questions and Answers	9
Manufactures	9, 10
Large Bullion Weighing Scales	10
Professor Sweet on the World's Fair	10
Sketches of an Apprenticeship. By W. S. Rogers	10, 11
Force, Motion and Work. By Pedro	11, 12
A Case of Spontaneous Combustion	12
Machinists' Supplies and Iron	12

New Lines of Employment for Women.

We see it announced in a newspaper published in a manufacturing town that women have been employed as coremakers in some foundries there, in place of the men and boys formerly employed for that purpose, and the comment of the newspaper upon this fact shows that it is considered to be fortunate that another avenue of employment is thus opened for women in that town.

We believe that where a woman actually wishes to follow any given occupation, there should be nothing to prevent her doing it. But whether or not the opening of new avenues of employment for women is a blessing or otherwise, it seems to us, depends greatly upon the motives which induce them to seek employment in lines of work hitherto monopolized by men. It seems easy to trace the final end of such movements in what is to be seen in some foreign countries, where women perform much of the heaviest and coarsest labor, and are made to do service as beasts of burden from early girlhood, until premature old age renders them unfit for further work. The result has been to reduce the wages received by the men, until it is a well-recognized fact that it is an impossibility to support a family upon them, and the female labor, which in its beginnings was perhaps voluntary, or only occasionally necessary, has become a universal necessity, the wages of the entire family being needed to keep body and soul together. There can be little doubt but that the same cause tends to produce the same result here, or, in other words, to bring about a state of affairs in which men will find it more and more difficult to earn by their labor sufficient to enable them to assume the responsibilities naturally devolving upon them as heads of families. As this difficulty increases, the necessity for female and child labor increases, and thus it is an evil which feeds upon itself, women displacing the men who should be earning the money to support households. Every able-bodied man who is industrious and willing to work ought to be able to make enough money by his work to support a family. We believe that nature's return for labor is sufficient for this, and where such men are not able to provide for those naturally dependent upon them, it must be that something is wrong, that people are being wronged, and in the end this wrong must inevitably have its effect upon social growth.

It is, perhaps, more true in this than in almost any other country, that whatever is prejudicial to the family and to home life is prejudicial to society, and we know of nothing that is more injurious to both than the tendency to put women and children at work which should be done by men.

Book Knowledge.

It is a question that has never been definitely settled, whether a young man who is to take both a school and a shop course should take the school course first or last. It is a question not likely ever to be settled, because the answer would, beyond much doubt, be different in the instance of different individuals. Probably the advice given through the AMERICAN MACHINIST by Prof. Sweet to Chordal in the instance of his (Chordal's) boy "Joe," is the best that can be given. That advice was: "Don't send him." In other words, let him make his own election as to which he will first do.

But it is not the boy who can go to both school and shop that we now have in mind; it is rather the one who must get along with the shop, and be a school unto himself. Boys of this kind form, to-day, the greater part of what is to be the future industrial population of the country. And it is not they alone that are interested in the kind of men they make. It is a subject in which the whole country is interested, and upon which the manufacturing importance of the country largely depends. It is a pity, perhaps, that every boy who starts out to follow a mechanical pursuit cannot have an education in some of our excellent technical schools, but it is a fact that only a small percentage of them can have such an education. Still there is no occasion for the boy who must acquire his own technical education, as best he can, to despair. On the contrary, he can educate himself—all by himself, if necessary—to almost any extent he may desire. We are not of those who believe in telling boys that this is an easy thing to do. There are many well-meaning people, who have the interests of young mechanics at heart, and who believe the proper way to start them systematically at work mastering what may be called the written part of their trades, is to intimate that this is easy of accomplishment. When a young man starts in to study the underlying principles of mechanics and engineering he is sure to find that it is not an easy task, and having been told that it was, what more natural than discouragement. It is far better to start with a full knowledge of the fact that there is hard work ahead, and then fully reflect upon the fact that a great deal of hard work can be got along with in a year by devoting an hour or two each day to it. Men have become accomplished linguists by such a course, and men can learn the written part of engineering and mechanics by a similar course. It means hard work and that is all there is to it, just as we have said before this.

Boys should understand that to become of much account in the trades and occupations where there is opportunity to employ a good deal of skill and knowledge, they must study the principles involved in these trades and occupations. The distinction between a workman and a mechanic was never so sharply defined as it is to-day; there is but little hopes of rising, and less of staying up, unless the workman has that general knowledge of his business that makes of him a mechanic. We may speak slightingly, as we will of "book knowledge," the workman of to-day who hopes to work up, must get, not a little, but a good deal of knowledge from books. The young men of to-day understand this fairly well; they understand that to become more than workmen, there must be the ability to plan as well as the skill to execute, but the determination to *begin* is too often lacking. The proper time to begin is always now—never next week or next year.

Our advice to a boy about to learn a trade is, in the present state of affairs, don't do it, unless at the same time you begin to study out of the shop in relation to those things connected with that trade. Learn why you put things into certain shapes, and why you use certain means to accomplish certain ends, at the same time you are learning to accomplish these ends. The mere workman is coming to be of less consequence every day; the man who does things for reasons that he fully understands, of greater consequence.

In how many sections of the country are steam pleasure launches allowed to be run on waters outside the jurisdiction of United States inspection, without any inspection or license? We hear a good many complaints about this, and in the main they are well founded. A few years since these pleasure boats were rare, and no such importance attached to their operation, as does now, when their number is so greatly multiplied. Such boats may now be found plying in great numbers on rivers and inland waters that are crowded with row-boats, and unless inspected, and their engineers and pilots subjected to some kind of examination to determine their abilities, they are a menace to life. We believe that every State should have and enforce a law covering the inspection of every steamboat plying on inland waters, whether it is used for pleasure purposes alone, or for carrying passengers. No one owning such a boat could reasonably object to this, and it would result in security to life.

As one consequence of the recent contest here in New York between the cloakmakers and their employers, some of the former, who have been unable to secure such terms as seemed to them to be fair, have opened a shop of their own, and it is stated have all the work they can attend to with fifty men and twenty-five machines. Upon this course we think the men are to be congratulated. The venture may not be successful, but even if it fails, it will do nothing which has not been done many thousands of times before, and every man who takes part in the enterprise will gain experience which will be valuable to him, and will be the better man for it, provided always, of course, that he does his level best to promote the interests of himself and fellow-workers. We shall hope the enterprise will be successful, as we hope that all similar enterprises, started by men who have found it impossible to satisfy a legitimate ambition by working for others, will succeed.

Literary Notes.

"Poor's Manual of Railroads" for 1890, from which we published some extracts in our issue of August 7, taken from an introduction sent out by the publishers, is at hand. Though it has seemed to be all that could reasonably be demanded in previous years, it is evident that considerable improvement has been made this year, the information being given with still greater detail, and maps of the principal railway systems being given. These maps, taken in connection with the historical monographs upon the different systems, are, of course, a great convenience, enabling any one to get a comprehensive knowledge of any railway system in the shortest possible time. There are fifty-one of these maps, and they are all excellent, not only in a geographical sense, but they also give the topographical features of the different systems. The book has been the standard for years, and still maintains its reputation. It can be had of the publishers, H. V. & W. H. Poor, 70 Wall street, New York City. Price, $6.

COMPLETE COLLECTION OF SHOPPELL'S MODERN HOUSES. Fifteen hundred illustrations. Published by The Co-Operative Building Plan Association, Architects, 63 Broadway, New York.

This is a large work, as will be inferred from the number of illustrations, and it contains designs consisting of perspective views and plans for cheap, medium and high-priced houses, and in such a variety as to enable the most fastidious to make a selection. Brief descriptions accompany the designs, and the cost of the structure is given. Application for patents on many of the designs have been made, which the publishers say is to prevent unauthorized copying, to the annoyance of the first to build a house of some chosen design. No charge is made for license to use any design that may be selected when the working plans, specifications, etc., are ordered from the publishers. The charges for plans and specifications, as given in the book, appear to be very reasonable. The book also contains hints on decoration, painting, landscape gardening, etc. The price is $10.

REPORT OF THE PROCEEDINGS OF TENTH ANNUAL MEETING OF THE AMERICAN WATER-WORKS ASSOCIATION, held at Chicago, May 20, 21 and 22.

This volume contains much that is of interest to those who have to do with water-works; the papers read, discussions and reports of committees dealing for the most part with problems that are continually arising connected with the management of a water-works plant. The association is undoubtedly doing a valuable work, and it is pleasant to be able to record that it is in a prosperous and vigorous condition. The volume is sold at 50 cents per copy, and can be had by addressing the secretary, Mr. J. M. Diven, Elmira, N. Y.

We have received the catalogue of the University of Virginia, for 1890-91, accompanied by the statement that the department of engineering is to be enlarged during the vacation by the addition of a mechanical laboratory and machine shop, and new classes will be formed on subjects relating to mechanical and civil engineering. The catalogue may be obtained by addressing the Chairman of the Faculty, University of Virginia, Charlottesville, Va.

One of the largest and finest catalogues that has reached our table for some time is

that of the University of Wisconsin, in which Prof. Charles I. King is Professor of Mechanical Practice. There are sixty-five members of the faculty, and the catalogue gives abundant evidence of the prosperity of the school.

We have received from John N. Reynolds, 140 Nassau street, New York, the semi-yearly *National Car and Locomotive Builder Supplement*. It contains 120 pages, exclusive of the cover, and gives a directory of car builders, wheel makers, axle makers, spring makers, locomotive builders, rail-mills, street railway companies, South American railways, etc. It is very convenient for reference.

The sixth number of *The Technic*, published at the University of Michigan, is full of interesting matter. This is the annual publication of the Engineering Society of the University, and has for its contributors the professors, alumni and students of the engineering departments. Much of permanent value is to be found within its covers. Its price is 50 cents.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(326) G. P. J., Allegheny City, Pa., writes: Please explain how an ordinary slide valve can be proportioned. *A.*—See our issue of May 1, current volume.

(327) H. W., Dennison, Ohio, writes: Please state the reason for placing the link saddle-pin out of the center of the link. There is considerable discussion on this subject in our shop. *A.*—The saddle-pin is placed out of the center of the link for the purpose of cutting off steam at equal distances from the end of each stroke of the piston.

(328) C. P. S., ———, Mich., writes: Please refer me to some book which treats on lathe and milling machine work; also on setting up machines. *A.*—We do not know of any book that treats on these subjects. We believe that shop practice and a general knowledge of mechanics and mathematics will enable you to become familiar with these subjects.

(329) F. H. S., Richmond, Va., writes: Please give me the name of a book which gives the names of all the different parts of a locomotive, its general management, and what should be done in case of a breakdown. *A.*—It is doubtful if you can get all the desired information out of one book. The following are good books: "Locomotive Engine Running and Management," by Angus Sinclair; "Catechism of the Locomotive," by M. N. Forney; also see articles on "Modern Locomotive Construction," recently completed in the AMERICAN MACHINIST.

(330) F. S., Union Hill, N. J., writes: I am part owner of a steam launch, and we have a 4 horse-power engine and boiler in it. I would like to know if I could run the engine and boiler without a license; if not, could I get a license, if the builders of the engine show me how to run it? I am not an engineer. *A.*—You will need a special license. You can obtain a license, provided you can pass the examination for one. 2 Please recommend me to a good insurance company. *A.*—We cannot do so. You must make your own choice.

(331) W. P., New York, asks: Do ocean steamships ever feed their boilers with salt water, or do they always condense it first? *A.*—On steamships which have surface condensers, salt water for feeding the boilers is not used; the feed water is taken from the condenser. If much steam is lost by leakage, then salt water is used to make up the deficiency, but the amount of salt water required for this purpose is very small. Formerly, when jet condensers were used, a considerable quantity of salt water was fed in the boilers. 2. What is the difference between a boiler in which salt water is used, and one in which fresh water is used? *A.*—There is no difference.

(332) A. W. H., Portville, N. Y., writes: I have built a steam launch according to the dimensions you gave me last spring. Length of boat, 18 feet; width, 4½ feet; wheel, 12 inches diameter by 22 inches pitch. I have plenty of power, so I want to increase the speed. I wish to run the engine 350 revolutions. What size of wheel and pitch will give the best results? *A.*—It would have been more satisfactory if you had given us the speed attained, and number of revolutions at which the engine has been run. If you simply wish to increase the speed, there are no objections to running the engine (2″x3″, which we assume to be the size of engine) at 450 revolutions per minute, and if at this speed you still require a larger propeller, try one 14 inches diameter and 24 inches pitch.

(333) D. A. H., Oxford, Nova Scotia, asks: What is the correct weight of a cubic inch and a cubic foot of cast and wrought-iron? *A.*—The weight of iron varies with the quality. If extreme exactness is required, the weight must be determined by actual weighing. In ordinary practice, the average weight is used. Haswell gives 450.437 pounds per cubic foot of cast-iron; 479.5 pounds for heavy forgings; and 486.75 for wrought-iron bars. According to Trautwine, the average weight per cubic foot of cast-iron is 446 pounds, and usually assumed at 450 pounds. The weight of pure wrought-iron is given at 485 pounds per cubic foot; large rolled bars at 474, usually assumed at 480; and sheet-iron at 485 pounds per cubic foot. For the weight per cubic inch divide these weights by 1,728. 2. I would like to continue the study of Practical Drawing further than given by Mr. Meyer in your paper; that is, to take up the study of perspective drawing; what book would you recommend? *A.*—The treatise on Shades and Shadows and Perspective, by Charles Davies, we consider to be a good book. 3. Where can I get reliable information on the construction and working of cutting tools for lathe tools, chucks, drills, taps, reamers, etc. *A.*—The best way to obtain this information is by experience in the shop. Probably the "Complete Practical Machinist," by Joshua Rose may help you.

(334) W. T., Washington, D. C., writes: I have been in the habit of fiting keys top and bottom, but leaving them loose sidewise to slide in without shake. This is contrary to my employer's practice. Please state which is the correct way. *A.*—There seems to be a difference of opinion on this subject. Tapered keys must fit tight on their tapered sides, and should have a nice sliding fit on their parallel sides. Since the tapered sides are generally on the top and bottom of the key, the key must fit tight on top and bottom. For keys which are not tapered, the purpose for which they are used should determine what part of the key should be tight. 2. A crank-shaft is to be fitted with a new crank. The shaft is 7 inches diameter. What should be the size of the hole in the crank? The crank is to be put on with hydraulic pressure. What pressure will be required? *A.*—The pressure should be about six tons per inch in diameter of the shaft, making the total pressure about $7 \times 6 = 42$ tons. The size of the hole in the crank will depend to a great extent on the quality of the metal, and therefore no rules can be given for determining the exact diameter of the hole in the crank, and good judgment and experience must be relied upon. A general rule is to make the diameter of the hole in the crank about the thickness of a thin sheet of paper less than that of the shaft. 3. How much must be allowed for making a shrinking fit? *A.*—About the same as that allowed for hydraulic pressure.

(335) J. G. O., Cleveland, O., writes: We are figuring on the strength of a bent lever, shaped something like the sketch. The point arose as to whether the conditions were the same for a bent lever as for a straight one. Would you kindly give us the solution of this problem? *A.*—Multiply the distance

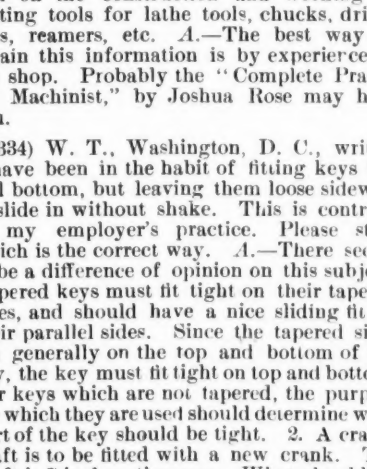


Fig. 1.

Fig. 2.

L in inches from the fulcrum to the direction in which the force P acts by the force P in pounds; the product will be the bending moment at the smallest cross-section $A\ C$, drawn through the center of the fulcrum Now, the working moment of resistance must be equal to the bending moment; if the former is less than the latter, the lever will break at the section $A\ C$. Let M denote the bending moment, and R the moment of resistance, then according to the foregoing $M = R$. The moment of resistance R is found by the formula $\frac{f}{m\,h}\,I$, in which f denotes the ultimate strength per square inch of the material, supposed to be the same for both skins, that is, for thrust and tension; m is the fraction which the distance from the neutral axis to the farthest away skin is of the depth; for all cross-sections, symmetrical above and below the neutral axis, as a rectangle, ellipse, hollow rectangle, etc., $m = \frac{1}{2}$; h the height of the cross-section; and I the moment of inertia. Let Fig. 2 represent the cross-section through $A\ C$, the moment of inertia I will be equal to $b\left(\frac{h^3 - h_1{}^3}{12}\right)$, hence our formula $\frac{f}{m\,h}\,I$ becomes $\frac{f}{\frac{1}{2}\,h} \times b\left(\frac{h^3 - h_1{}^3}{12}\right)$

Now, remembering that $M = L\,P$, we have

$$L\,P = \frac{f}{\frac{1}{2}\,h} \times b\left(\frac{h^3 - h_1{}^3}{12}\right)$$

and

$$P = \frac{\frac{f}{\frac{1}{2}\,h} \times b\left(\frac{h^3 - h_1{}^3}{12}\right)}{L},$$ in which

all the dimensions must be taken in inches. In order to find the strength at any other cross section, $B\ D$ for instance, we first find the bending moment M by multiplying the distance l, in inches, by the force P, in pounds; the product is the bending moment. The moment of resistance R is again equal to $\frac{f}{m\,h}\,I$; but here, since the cross-section is a solid rectangle, I is equal to $\frac{1}{12}\,b\,h^3$, in which b is the breadth, and h the height of the section in inches. Hence for the section $B\ D$, we have

$$l\,P = \frac{f}{\frac{1}{2}\,h} \times \tfrac{1}{12}\,b\,h^3 = \tfrac{1}{6}\,f\,b\,h^2$$

and

$$P = \frac{\frac{1}{6}\,f\,b\,h^2}{l}.$$

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Friday morning for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 20.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., 8 Spruce St., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Ice and Refrigerating Machines, 155 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Valve Seat Rotary Planing Machine. Pedrick & Ayer, Philadelphia, Pa.

Cylinder Boring and Facing Machines. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Standard Tool Co.'s Twist Drills. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

One Star Hack Saw will do as much work as five of any other kind.—N. B.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Most sensitive and durable Damper Regulator made; works within one pound; send for circular. T. Kieley, 11 W. 13th st., New York.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

"Roper's Hand-Books," for engineers and firemen. Send for descriptive catalogue. Address Edward Meeks, publisher, Philadelphia, Pa.

Horton's Chucks. We offer the balance of our stock at 50 per cent. discount. McFadden Co., Philadelphia, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See August 7, p. 19. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

25″ 28″ 32″ 36″ Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E. Snyder, Worcester, Mass.

25″ 32″ 37″ 42″ "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

For Sale—Bound volumes of the Patent Office Gazette for years 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per year. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations, 8vo, cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

Screw Propellers. Manufactured by H. B. Roelker, 22 Cortlandt st., New York. Superintendent of the late De Lamater Iron Works, of same patterns and designs as before, adapted to each vessel. Consulting Expert and Constructing Engineer. Estimates on machinery, damages, etc. Air ice machines.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES.

Huntingdon, W. Va., is to have a bicycle factory.

Carter Bros. will build a shingle mill at Milton, Fla.

A saw-mill will be built at Cane Ridge, La., by Mayberry & Brothers.

The Batesville Iron Works, of Batesville, Ark., intend adding a foundry.

Mayberry Brothers & Company are erecting a saw-mill at Cane Ridge, La.

The Straight Line Engine Company, Syracuse, N. Y., is crowded with orders.

J. B. Bennett is making efforts to secure the location of a furniture factory at Opelika, Ala.

It is stated that an iron foundry and machine shop will be established at Arkadelphia, Ark.

A saw and shingle-mill is to be erected at Milton, Fla., by W. C. & L. C. Cater, of Greenville, La.

A stock company will probably be organized, to establish an ice factory at Greensborough, Ala.

The Wilkesborough (N. C.) Manufacturing Company will enlarge capacity and add new machinery.

It is stated that the Lawrence Iron Works, of Ironton, O., will move its rolling-mill to Glasgow, Va.

The Globe Iron Foundry, at Erie, Pa., will shortly double its capacity by the erection of an additional plant.

The Cincinnati Corrugating Company, of Piqua, O., are adding a galvanizing department to their sheet-mill.

The foundations are being laid at Exeter, N. H., for Raymond's new shoe factory, three stories, 170x30 feet.

The Prescott corporation, Lowell, Mass., are to extend a wing of their factory and make it three stories high.

J. S. Dewing & Co., the furniture manufacturers at Orange, Mass., are building a large addition to their factory.

J. A. George, Rome, Ga., has prepared plans for a three-story machine shop 60x100 feet, and a foundry 30x50 feet.

The erection of an electric light plant and the construction of water-works is projected at Arkadelphia, Ark.

The Bridgeport (Ct.) Chain Company is erecting a factory 150x42 at the East End, the result of increasing business.

The Edison Company are to put an electric light plant into the factory of C. H. Dexter & Sons, at Windsor Locks, Ct.

A $300,000 stock company has, it is stated, been organized, to establish boiler and machine works at Buena Vista, Va.

The Casey Boiler Manufacturing Company, of Chattanooga, Tenn., will make extensive additions to the present plant.

It is stated that the Curtis Creek Mining and Manufacturing Company will build a knitting-mill at Glenburnia, Miss.

The Hendey Machine Company, of Torrington, Ct., are to build another addition to their factory, 50x80 feet, one story high.

An addition is being built to the mill of the S. V Beach Paper Company, Seymour, Ct., to accommodate its increasing business.

The Fishkill Landing Machine Company, Fishkill-on-the Hudson, N. Y., expect to increase capacity by further addition to works.

The Lookout Boiler Works at Chattanooga, Tenn., have purchased additional space, and are now enlarging their plant, and adding much new machinery.

The Savannah, Americus & Montgomery Railroad Co. is reported as putting new machinery in its machine shops at Americus, Ga.

The Mobile (Miss.) Jackson & Kansas City Railroad Company has made the city a proposition to erect machine shops and roundhouse.

A $500,000 stock company has been organized, to build reduction works at Mineral City, Va. The ore is to be taken from the Walton mine.

The Bristol Pioneer Steel Plant and Rolling-mill Co., has been organized, at Bristol, Tenn., to build two Bessemer and two basic steel furnaces.

Healy & Brown are having the foundations laid for their new shoe factory at Exeter, N. H. The building will be three stories high, 300x170 feet.

A malleable iron plant is shortly to be added to the foundry and machine shops of the Ross-Mehan Brake Shoe Foundry Company, at Chattanooga, Tenn.

The Arkansas & Texas Consolidated Ice and Coal Co., Camden, Ark., will operate an ice factory. A site has been purchased, and work will commence shortly.

The Farmers' Alliance at Troy, Ala., is going to build a cotton bagging factory. A stock company will be started, and it is hoped to build at once.

Dearborn Bros. have the contract for building the new factory L of the Thomson-Houston Company at Lynn, Mass. It will be three stories high, 60x100 feet.

Messrs. Ireland & Hughes, Pittsburgh, Pa., manufacturers of oil well tool supplies, contemplate the erection of a 50-foot addition to their forge department.

Hertweck, Baltzer & Company, Hickman, Ky., are rebuilding their paint and blacksmith shop, recently destroyed by fire. Each building will be 125x80 feet in size.

The Orangeburg Electric Light and Electric Power Co. has been incorporated by E. F. Slater, I. M. Oliver, and C. G. Danzler, to erect an electric light plant at Orangeburg, S. C.

The Chicago Rapid Railroad Velocipede Company, of Chicago, has been incorporated by J. H. Gray, D. W. Gale and Charles Kotz, for the manufacture of railroad velocipedes.

The foundations are now being built for the new mill of the Barnaby Manufacturing Company at Fall River, Mass. The new building will increase the capacity of the mill one-half.

It is stated that capitalists interested in the Norfolk & Western Railroad will build the large steel plant projected at Lambert's Point, Va. The site is said to have been selected.

The Diebel Sewing Machine and Trimmer Manufacturing Co., Philadelphia, Pa., has changed its firm name to The Appleton Manufacturing Co., which change is announced by circular.

Jones & Laughlin, of Pittsburgh, Pa., contemplate the erection of a third furnace, and work on it will commence about September 1. About $200,000 will be expended on the new plant.

The Basic City (Va.) Car Works Company is erecting machine shops and foundry 60x100, planing, tongue, and grooving-mills 60x100 feet each, erecting shop 60x143 feet, and paint shop 17x143 feet.

The Richland Manufacturing Co. has been incorporated, with a capital stock of $10,000, to manufacture ice and lumber, and operate a cotton gin and grist-mill at Rayville, La. It will erect a 5-ton ice machine.

The tack factory of Fosgate & Lane, at Auburn, N. Y., will be moved to Harriman, Tenn., and operated by the Harriman Tack Co. It is stated that a site has been selected and a brick building 40x175 feet will be built.

The Parkersburgh (W. Va.) Chair and Furniture Company, which has its buildings completed, but which has not gotten to work yet, has made a proposition to Mr. Hastings to turn its plant over to him for a nail-mill.

The Duthie Engine & Machine Shops, of Knoxville, will, it is stated, be removed to Harriman, Tenn., and operated by the Duthie Machine and Foundry Co., which has been organized with a capital stock of $20,000.

An experimental furnace is being erected by the Steel and Iron Improvement Company at the Black Diamond Steel Works of Park Bros. & Co., at Pittsburgh, Pa., for making steel direct from the ore by the Adams process.

The Enterprise Mfg. Co., Tallahassee, Fla., of which Geo. E. White is manager, will add to their lumber business the manufacture of laths and shingles, pails, tubs, barrels, and some departments of work in the furniture line.

The steel plant which the Norton Iron Works and the Kelly & Belfont Mills, of Ironton, O., propose building at Ashland, Kentucky, will cost $350,000 to $400,000. It is said that $100,000 of the capital stock has been subscribed in Ashland.

It is said that an iron pipe works, a nail factory passenger and electric car works, a foundry and machine shop, a woodworking factory, a box factory, and a sash, door and blind factory will be established at Goshen Bridge, Va.

H. M. Lewis, of Hamilton County, Ohio, and J. S Pessinger, of Kings County, New York, have incorporated the National Railroad Forging Machine Co., to manufacture railroad forgings, at Covington, Ky. The capital stock is $200,000.

Harrington & Company, whose planing mill at Troy, N. Y., was totally destroyed by fire Friday morning, are to rebuild on the site of the burned structure as soon as the insurance is adjusted. The new mill will be larger than the old one.

The Hoggson & Pettis Mfg. Co., New Haven, Conn., write us: We suffered by fire on Sunday to the amount of $1,500; covered by insurance. Cause, spontaneous combustion. This will delay us somewhat in getting into our new forge shop.

The Sumter Ice Manufacturing Co., lately reported as organized to erect an ice factory at Sumter, S. C., has been incorporated with J. J. Harby, president, and E. H. Moses, vice-president and secretary. The capital stock is $10,000.

The Rome (Ga.) Rolling-mill has been purchased for $38,500 by B. A. Jenkins, of Knoxville, Tenn., J. J. Reed, D. R. Beynon and others, who have incorporated the Rome Cotton Tie Manufacturing Co., to operate same. The plant will be enlarged.

The Diamond Clamp and Flask Works, Richmond, Ind., are putting up a new building, which they will equip with the latest machinery for the manufacture of their specialties, including the Diamond folding snap flask, illustrated in our August 14th issue.

The Richmond & Danville Railroad (office, Richmond, Va.), intends building additional machine shops, and will probably locate one of them in Charlotte, N. C. The company has purchased a large tract of land, which is probably intended for a site.

The Goshen Rolling-mill Co. have been incorporated at Goshen Bridge, Va., with $300,000 capital stock. The officers are: Henry Stephen, president, and J. Y. Heckman, secretary. This company is backed by Philadelphia capital. The works will be erected at once.

The Thomas Manufacturing Co. is contemplating the enlargement of its cotton press factory at Little Rock, Ark., and will probably erect a new two-story building, 50x200 feet, for its woodworking department, and use the present building for foundry and machine shop.

Charles A. Schieren & Co., manufacturers of leather belting and lace leather, 45-51 Ferry street, New York, have issued a little pamphlet in which the different processes of manufacture are explained and illustrated. It will prove interesting to those unacquainted with the matter.

R. S. Newbold & Son, of Norristown, Pa., have been awarded the contract for a train of rolls, squeezer, six steel boilers, and a stack for a new rolling-mill for Hughes & Patterson, on Beach street, Philadelphia, on the site of a mill formerly operated by Stephen Robbins.

It is reported that a company is being organized by capitalists interested in the Norfolk & Western Railroad to build a basic steel plant at Salem, Va. This is in addition to the McCarthy steel plant to be built at Salem, and upon which it is understood work is to be commenced shortly.

Charles Churchill & Co., limited, 21 Cross street, Finsbury, London, E. C., England, hand us a very complete and well-arranged catalogue of American tools of nearly every description, which are sold at their rooms. The catalogue is well illustrated and printed, and contains a convenient table of contents.

The Lockhart Company's plant, at Chartiers, Pa., is shut down for repairs. The old muck train is to be replaced with 3-high rolls. Four new puddling furnaces are in course of erection, and ten more will be built when these are lighted. By these improvements the daily capacity will be increased nearly 75 tons.

Work upon the building of the new electric Company at Pittsfield, Mass., will begin within a fortnight. The plans of the building have been somewhat altered, and instead of one it will be two stories high, flat roof, 90x60. The cost of the building and land, which was bought of Barker Brothers, will be about $30,000.

The Tyler Tube and Pipe Company are about ready to start their tube and pipe-mill, recently erected at Washington, Pa. They will make their own skelp iron, having put in an 18-inch 3-high Garrison roll train for that purpose. The firm is erecting a number of dwelling houses near the new works, to be occupied by the workmen.

In a recent issue the types made us say of the new shop being built by the Waltham Emery Wheel Company, Waltham, Mass., that it would be 24x50 feet. The dimensions are 240x50 feet. This company has been constantly extending its business since it was organized, and the new works will be built in such a way as to facilitate future additions.

We have received from Tower & Lyon, 95 Chambers and 77 Reade streets, New York, catalogue No. 7, of hardware specialties manufactured by the firm. In this catalogue are illustrated a large variety of mechanics' tools, vises, locks, police equipments, lamps, lanterns, etc. The catalogue contains 126 large pages, and several hundred engravings, and is excellent for reference.

The *New Haven* (Conn.) *Palladium* says that a new company, to be known as the Dwight Gridley Company, is to build a large factory and foundry in West Haven, Conn. The articles to be manufactured are recently patented self-locking brass racks for lamps, plants, etc. The capital stock is to be $100,000, divided into 4,000 shares of $25 each, and among the capitalists who have already purchased stock are Senator James Graham, Charles Graham and Elliott H. Morse. A site on the water front will probably be secured, and the buildings, which will be about 60x100 each, erected as soon as possible.

A Duluth (Minn.) dispatch says: Negotiations are in progress and practically completed by which the entire steel plant of the Harper-Swift Company, located in one of the suburbs of Cincinnati, will be transferred to Duluth. In Cincinnati the plant occupies 15 acres of space, and 20 acres have been set apart for it in close proximity to West Duluth. One thousand men will be required for day work and 500 for the night shift. The cost of the entire plant will be $1,000,000. The proprietors of the enterprise are Messrs. Joseph Sellwood, E. L. Emery, E. C. Gridley, F. C. Bowman, A. M. Stearns, M. Douglass, of Duluth, and W. C. Stearns, of Chicago. The company controlling the steel plant will be entirely reorganized, with new men and larger capital. Beside the gentlemen named, J. W. Norton, of Louisville, C. E. Lovett and B. D. Brown, *et al.*, will furnish a portion of the capital and take stock in the concern. The principal business of the company will be the manufacture of structural steel and iron shapes, and the rolling of bars, plates and merchant steel shapes.

Large Bullion Weighing Scales.

A large pair of scales intended for weighing large parcels of silver bullion, lately completed by Messrs. De Grave, Short & Fanner, to the order of the Indian Government, for use in the Bombay Mint, was examined recently, on the invitation of the makers, at their new works in Farringdon road, by several engineers and others interested in precise weighing machinery, on the occasion of the final adjustment before delivery. The beam of this instrument is a plain forging in wrought-iron 11 in. deep in the center and 3½ in. at the springing of the end boxes which carry the knife edges for supporting the pans, the thickness being also tapered from 1¼ in. in the center to ¾ in. at the end of the arms. The total length of the beam between the points of suspension of the pans is 6 ft. The central knife edge is a rectangular prism of hardened cast-steel about 1¼ in. on the sides of the right angle and 5 in. long in the direction of the axis; those carrying the pans are mounted in slotted guides in the end boxes, having set screws for adjusting the arm to the proper length. The pans are square platforms covered with copper and suspended by stout galvanized chains; their weight is about 1 cwt. each, and that of the beam 4 cwt. When tested empty the addition of $\frac{1}{16}$ of an avoirdupois ounce was sufficient to deflect the index through the whole range of the powerful scale, and when loaded with 5½ cwt. on each scale, under which condition the load on the central knife edge is about 14 cwt., a deflection of four divisions of the scale is produced by one gramme, which corresponds approximately to $\frac{1}{8800}$ of the load to be determined; a degree of susceptibility that is very remarkable, having regard to the simple and sturdy construction of the instrument, but which speaks volumes as to the perfection of workmanship in the essential parts. Several other scales and balances have been constructed for the Indian and Australian Mints, but the present example is far larger than any of its predecessors.—*London Engineering.*

Professor Sweet on the World's Fair.

Professor John E. Sweet recently addressed a letter to Mr. M. C. Bulloch, of Chicago, on the subject of the World's Columbian Exposition, which letter has found its way into the columns of the *Inter-Ocean*, and that journal commends its careful consideration by those having responsibility in the matter. The Professor points out that Chicago cannot make the fair a success; the energy of the whole nation will be required, and all the world must help make the exhibit. Whether or not these things will be done, he says, depends on the completeness and liberality of the plan, and the treatment received from Chicago. The plan of holding the fair in two places six miles apart is condemned. We quote:

Two places for holding the exhibition six miles apart will be trying for the second time what proved a failure the first—that is, so far as the left-out end of the show was concerned. The scheme of giving a free ride and back from one section to the other, however well it works in practice, means that some one has to pay, and that some one in the end is the visitor. But is it sure to work well in practice? Is not the public way liable to be crowded, mixed and filthy? Is it not sure to end in two classes—a paid class and a free class? The free to grow smaller and smaller and less desirable, that the paying class may grow larger, and in the end each of the two sets become dissatisfied, the one because the accommodations are not satisfactory, and the other because they have to pay for that which they were to receive for nothing. This reminds me of one of the remarkable features of the last Paris exhibition—the absence of catch-penny attachments, and the remarkably low cost of admission. From 12 to 16 cents was the average cost for admission through the day, and from 20 to 40 cents for the evenings.

Professor Sweet in his letter brings into clear relief the difference in the effect between plans to make a great fair and plans to speculate in real estate and the necessities of visitors, gives hints as to the buildings required, and lays particular stress upon the fact that a good deal of work must be done in the way of getting the people started in the work of preparing for their exhibits early enough. Regarding the money question, he writes as follows:

I have no doubt you will notice particularly the point I wish to make on the money question, laying special stress on what may seem to be to the left-hand interest of Chicago, and I do this because it is exactly what those who have the final interest of the exhibition and the welfare of Chicago at heart have got to fight for.

It is believed, and with truth, that Americans abroad often get swindled. It is imagined, without any truth whatever, that all Frenchmen, Italians, and, in fact, all foreigners, are swindlers.

Now, it is equally true that foreigners coming to this country get swindled, not only in New York, but in our little Syracuse and your big Chicago.

The swindlers of Chicago are going to look upon the fair as their special harvest, and all that is necessary to kill the exhibition is to let them have their own sweet will during the months of preparation and a month at the opening. You may say, as Ben Wade did to Douglas, "Well, what you going to do about it?" Let those in power say they are going to prevent it, and if they have not the genius to do it they are not equal to the positions they accept. It cannot be prevented easily, but it can be pretty effectually.

Sketches of an Apprenticeship.

By W. S. Rogers.

I.

I never go through a machine shop, and see the honest young apprentice, or, as he is more familiarly known in shop lore, "the cub," with the black, greasy finger-marks around his nose, toiling for his employer and gaining the practical kinks and education found only in shop practice—things that will in time make him a worthy craftsman—without a feeling of envy. For I recall the brightest days of my boyhood. I shall never forget the morning I first donned my "suit of blue," and joined that noble army, the "tin-bucket brigade." And the remembrance of that first day's noon lunch comes to me so strong, even yet, when I see the cub of to-day square himself beside his dinner-pail, that I feel like joining him.

The shop was a peculiar one in its way, and the owner was peculiar in his way, and I felt two inches taller as he painted in gaudy colors the glorious future before me as a perfect workman, if I remained three years in his shop as an apprentice at three dollars a week.

It was rather hard to get up early enough every morning to be at the shop at 6 o'clock and get up steam, for I was the "engineer" as well as apprentice (an honor held by no other cub in town, my boss told me). It was rather hard to stay until all had gone home, and lock up the shop, but it was the only way to become a finished mechanic in the end, so I tried to whistle and enjoy it. Being the "engineer," I soon saw that the engine could be improved, and, wiping the grease from the monkey wrench, I started in to take the "pound" out of her. I don't recollect anywhere since of an engine that pounded like that one. All over the shop, from the office door to the top of the stack, that engine pounded. Despairing at last in my efforts to locate it, I put the wrench away, and hammered the main rod keys

down one morning. Finding that it was an improvement, at noon I tried the hammer on them again. Early in the afternoon, just as I was flattering myself over my rapid progress as a mechanic, that engine concluded to stop, and after the hands had taken off the main rod, filed out the cut spots, and cooled the wrist pins, we started again. During the recess for repairs the boss gave me my first lecture on applied mechanics, which was noticeable for its lack of flowery sentiment, and its vigorous delivery. The moral of that day's lesson is that "monkey wrench engineers" are luxuries few shops want around. Also a plain statement of cold facts makes a better impression and carries more conviction than the same facts imbedded among Oriental frosting. Also blue overalls don't make a mechanic any more of one man than writing his name on the letter-heads of a large corporation as president or manager does of another.

Force, Motion and Work.

By Pedro.

SIXTEENTH PAPER.

WORK.

Work, generally speaking, is the total effect produced upon material bodies by any active agent in overcoming resistance. For example, a horse, exerting his strength in moving a vehicle, is doing work. A man, carrying bricks upon a building, is doing work. Steam, moving the piston of an engine, performs work. Gravity, urging water down a stream, and over the falls, is performing work.

In the twelfth paper, Equation 47, we have seen that the weight, w, of a body, is a measure of the static force, f, which produces motion in a free body. Hence we may substitute f for w in Equation 35, eleventh paper, which gives us for the effect produced

$$57 \ldots\ldots\ldots\ldots e = f\ s = f\ v\ t.$$

This equation, as we have seen, represents the effect produced only when the body offers no resistance to motion, except that of inertia. When there are other resistances it requires more force than f to produce a given motion, as we have seen in Equation 53, etc., fifteenth paper; hence Equation 57 does not represent, generally, the *total* effect produced. To make the equation general, we must substitute the total resistance, f_1, for the inertia resistance, f. Making this substitution in Equation 57, and representing the total effect by W, we get

$$58 \ldots\ldots\ldots\ldots W = f_1\ s = f_1\ v\ t.$$

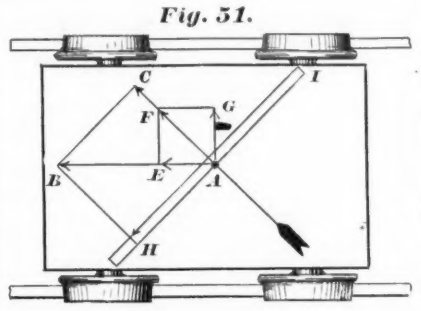
This total effect produced in the time t is what is called *work;* hence,

Rule 58.—The total effect produced or *the work performed in any time t is obtained by multiplying the total resistance of the body by the space passed over in that time.* In other words, it requires an amount of static force which is represented by f_1 for every unit of space through which the body is moved, the force always acting in the direction of the motion, as stated in the second law. For example, if a resistance of one pound is overcome over a space of one foot, we have the unit of work—*one foot pound*, or *one foot-pound-minute*, when the time is taken into consideration, and the motion occupied one minute. If the space is two feet, it requires two foot-pounds to produce the motion. Again, if $f_1 = 2$ pounds, and $s = 2$ feet, then the work required is $2 \times 2 = 4$ foot-pounds. If $f_1 = 5$ pounds, and $s = 2$ feet, then $W = 5 \times 2 = 10$ foot-pounds, etc., as already illustrated in the eleventh paper.

We have seen in previous papers that the space unit which is used in measuring common force is that of gravity ($\frac{1}{2}\ g$). In measuring work—the effect of overcoming resistance generally—the absolute unit, the foot, is always used in the English system. Hence work is always expressed in *foot pound-minutes* instead of gravity-pound-minutes. When the space is considered without regard to the time required to move the body over it, then the work is usually expressed simply in *foot-pounds*.

When the motion of the body is not in the direction of the force, then the work performed by it is obtained, either by the product of the space, and that component of the force which is in the direction of the motion, the other component being at right angles to the motion, since this has no effect in moving the body. Or the work may be obtained by the product of the force, and that component of the motion which lies in the direction of the force, the other component being in the direction at right angles to the force.

Fig. 51.



For example, take a car, Fig. 51, moving on a railway track, and suppose it to be propelled by the wind exerting a pressure on a board or sail, $H\ I$, in the direction, $A\ C$, indicated by the arrow. Let $A\ B$ be the velocity of the car, then will $A\ C$, the side of the parallelogram $A\ C\ B\ H$, be the component velocity in the direction of the pressure. Let $A\ F$ be the effective pressure exerted by the wind, then will $A\ F \times A\ C$ be the work performed in one minute, since $A\ C$ is the space passed over in that time by the active agent in the direction of its action.

Again, let us resolve the pressure $A\ F$ into two components, $A\ E$ in the direction of the motion and $A\ G$ at right angles to it. The component $A\ E$, being in the direction of the car's motion, is the pressure which does the work of moving the car in that direction, hence the work performed in the direction of the car's motion is $A\ E \times A\ B$.

It is easily shown that either of these two methods will give the same result, for the triangles $A\ F\ E$ and $A\ B\ C$ are similar, having the common angle $F\ A\ E$; hence by proportion we have

$$\frac{A\ F}{A\ E} = \frac{A\ B}{A\ C}, \text{ from which}$$

$$A\ F \times A\ C = A\ E \times A\ B.$$

The first member of this equation is the work as obtained by the first method of resolution, while the second member is that obtained by the second method.

If the physical resistance of the car is $A\ E = 20$ pounds and its velocity $A\ B =$ 80 feet a minute, then it will require 1,600 foot pounds of work a minute to keep the car moving with a uniform speed.

It appears from the above that work has a resemblance to absolute force, since both are measured in foot-pound minutes. Force, as we have seen in the eleventh paper, is the product of the weight (amount of matter or static force of gravity), and the *distance* it is moved in *one minute*. Work is the product of the static force required to move the body and the *distance* it is moved, without regard to the time required to move over that distance. Or we may say that force is the *intensity* while work is the quantity of an effect produced. Or, again, force is the *space rate* at which an effect is produced; for by making $s = 1$ foot in Equation 58 we have the work performed over one foot of space, the same as the force. Hence work may be geometrically represented in the same manner as force.

For example, in the twelfth paper, Fig. 28 represents the unit of work when $A\ B$, the time of motion, is one minute, and $A\ D = 1$ pound is the static force required to move the body with the average velocity $A\ E = 1$ foot.

Fig. 29 represents three foot-pounds of work performed by a static force, $A\ D$, of three pounds, which moves the body with a velocity, $A\ E$, of one foot in one minute, $A\ B$.

Fig. 30 shows 12 foot-pounds of work performed by a force $A\ D = 3$ pounds passing over a space $A\ B \times E\ E = 4$ feet.

In all these diagrams is represented the amount of work done in one minute, that is, the *rate* at which any body is working. This is called the *power* of the active body. For example, we would say that a horse's *power* was 20,000 foot-pounds if he was capable of doing work at the rate of 20,000 foot-pounds a minute. When we speak of the *power* of a steam engine we refer to the amount of work it is capable of doing in one minute.

Let us call attention here to the fact that "the work done in one minute," and "the rate at which work is done," are not necessarily identical expressions. They are the same when the work is uniform, but not when it is variable. Power bears the same relation to work that velocity does to motion. In uniform motion the velocity is the distance passed over in one minute, but in variable motion it is not, as we have seen in the fourth paper; in both cases, however, the velocity is the *rate* of the motion. So, also, the power is always the *rate* at which work is being done. When the force is constant and the velocity uniform, then the power is the work done in one minute. In variable motion the power is variable, and it is the work which *would be done in one minute* if the driving force and velocity would remain constant during that minute, the same as velocity in variable motion. Hence, the power is always obtained by multiplying the driving force by the velocity, as represented by Figs. 28, 29 and 30.

In measuring large quantities of work a larger unit than the foot-pound is generally used. This is called a horse-power—abbreviated H. P. This term was introduced by James Watt when he invented the steam engine. The work of horses being well known at that time, it was natural to compare the work done by the new motor—the steam in the engine—with that done by a horse. By the average of a number of experiments, Watt found that a horse could do 33,000 foot-pounds of work a minute without overworking him. Hence, he adopted the "horse-power" of 33,000 foot-pounds of work, and applied it to his engine to determine how many horses' work the engine was capable of doing. To reduce *foot-pounds* to *horse-power* we have simply to divide the power by 33,000, and the quotient will be the work in horse-powers.

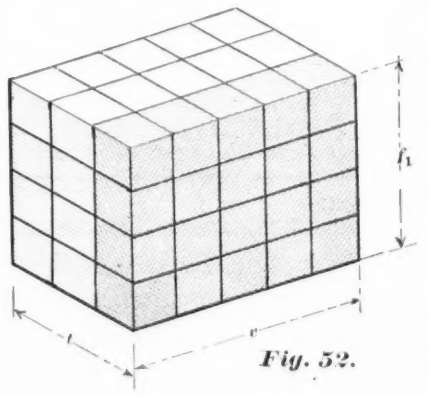


Fig. 52.

The pile of blocks shown in Fig. 52 is a general geometrical representation of all the dynamical conditions of a body, moving with a uniform motion, that we have studied in the foregoing papers.

First, we have the velocity of the moving body. This is represented by the length of the pile, v.

Second, the time of the motion is the width, t, of the pile.

Third, the space passed over by the body in the time t is the lower or upper surface of the pile—$v\ t$, generally.

Fourth, when the force of a body is considered, then the height of the pile is the body's weight, and the amount of force required to produce the motion is the volume of that portion of the pile which is one time unit in width, and is represented by the diagonally shaded portion, the average velocity, v, being measured in terms of $\frac{1}{2}g$, as we have seen in the twelfth paper.

The volume of the whole pile in this connection is generally called the "quantity of motion" (a misnomer), being the product of the accelerating force by the time t. The accelerating force, then, is obtained by dividing the "quantity of motion" (dynamic force) by the time. We have found neither a need nor a logical reason for the use of such a term, and therefore it has not been introduced into the preceding discussions.

Fifth, in considering the work performed by an active body the height, f_1, of the pile, represents the total resistance of the passive or driven body, or, which is the same thing, the force, f_1, exerted by the active body. In this case the diagonally shaded portion, one time unit in width, represents the power of the active body. The whole pile is the work done by the active body in the time t.

In every case the block shaded darker than the rest (or any block, for they are all equal to each other), represents the unit. The linear dimensions of the block represent the unit of velocity, time and weight or static force. The surface of one side of the block represents the unit of space, or motion. Its volume represents the unit of force, or work.

Since the power of a body is the work done in one minute when working at a uniform rate, we get from Equation 58, by taking the work of one minute, and representing the power by P,

$$59 \begin{cases} \text{I} \ldots\ldots\ldots\ldots\ldots P = f_1\ v \\ \text{II} \ldots\ldots\ldots\ldots\ldots P = \dfrac{f_1\ s}{t} \\ \text{III} \ldots\ldots\ldots\ldots\ldots P = \dfrac{W}{t}. \end{cases}$$

Rule 59.—To find the power:

I.—Multiply the driving force by the velocity, or

II.—Multiply the driving force by the space and divide the product by the time of motion, or

III.—Divide the work by the time of motion.

The following formulas may be obtained from Equations 58 and 59 (III.), or they may be written directly from the diagram, Fig. 52, for a uniform motion.

$$60 \begin{cases} \text{I} \ldots\ldots\ldots\ldots\ldots W = P\ t. \\ \text{II} \ldots\ldots\ldots\ldots\ldots W = f_1\ s. \\ \text{III} \ldots\ldots\ldots\ldots\ldots W = f_1\ v\ t. \end{cases}$$

Rule 60.—To find the work done by an active body in maintaining a uniform motion:

I.—Multiply its power by its time of action, or

II.—Multiply the driving force exerted by the space passed over, or

III.—Multiply the driving force by the velocity and the time of motion.

$$61 \begin{cases} \text{I} \ldots\ldots\ldots\ldots\ldots t = \dfrac{W}{P} \\ \text{II} \ldots\ldots\ldots\ldots\ldots t = \dfrac{f_1\ s}{P} \\ \text{III} \ldots\ldots\ldots\ldots\ldots t = \dfrac{W}{f_1\ v} \end{cases}$$

Rule 61.—To find the time of a uniform motion:

I.—Divide the work by the power, or

II.—Multiply the driving force by the space and divide by the power, or

III.—Divide the work by the product of the driving force and the velocity.

$$62 \begin{cases} \text{I} \ldots\ldots\ldots\ldots\ldots f_1 = \dfrac{W}{s} \\ \text{II} \ldots\ldots\ldots\ldots\ldots f_1 = \dfrac{P\ t}{s} \\ \text{III} \ldots\ldots\ldots\ldots\ldots f_1 = \dfrac{P}{v}. \end{cases}$$

Rule 62.—The driving force producing the motion is found by

I.—Dividing the work by the space, or

II.—Multiply the power by the time and divide by the space, or

III.—Divide the power by the velocity.

$$63 \begin{cases} \text{I} \ldots\ldots\ldots\ldots\ldots s = \dfrac{W}{f_1} \\ \text{II} \ldots\ldots\ldots\ldots\ldots s = \dfrac{W\ v}{P} \\ \text{III} \ldots\ldots\ldots\ldots\ldots s = \dfrac{P\ t}{f_1} \end{cases}$$

Rule 63.—To find the space passed over:

I.—Divide the work by the driving force, or

II.—Multiply the work by the velocity and divide by the power, or

III.—Multiply the power by the time and divide by the driving force.

$$64 \begin{cases} \text{I} \ldots\ldots\ldots\ldots\ldots v = \dfrac{W}{f_1\ t} \\ \text{II} \ldots\ldots\ldots\ldots\ldots v = \dfrac{P\ s}{W} \\ \text{III} \ldots\ldots\ldots\ldots\ldots v = \dfrac{P}{f_1} \end{cases}$$

Rule 64.—The velocity may be found as follows:

I.—Divide the work by the product of the driving force and the time, or,

II.—Multiply the power by the space and divide the product by the work, or

III.—Divide the power by the driving force.

For a few examples relating to the previous rules, let us assume a horse-car to be propelled by a horse.

Example 1.—Suppose the horse exerts a steady pull of 50 pounds over a distance of 200 feet, how much work does he perform? From rule 60 (II.)

$$W = 50 \times 200 = 10{,}000 \text{ foot-pounds.}$$

Example 2.—If the car moves with a velocity of 600 feet a minute, what is the power with which the horse is working? Rule 59 (I.) gives

$$P = 50 \times 600 = 30{,}000 \text{ foot-pounds.}$$

Example 3.—The work performed in passing over the distance of 200 feet being 10,000 foot-pounds, and the power 30,000 foot-pounds, what is the time required to pass over the distance? Rule 61 (I.) gives

$$t = \frac{10{,}000}{30{,}000} = \frac{1}{3} \text{ of a minute,}$$

or 20 seconds.

Example 4.—Given, the power, 30,000 foot-pounds, and the velocity, 600 feet a minute, how much does the horse pull? Rule 62 (III.) gives

$$f_1 = \frac{30{,}000}{600} = 50 \text{ pounds.}$$

Example 5.—The work performed being 10,000 foot-pounds by an exertion of 50 pounds, what is the distance passed over? From rule 63 (I.)

$$S = \frac{10{,}000}{50} \quad 200 \text{ feet.}$$

Example 6.—What is the speed of the car if the horse pulls 50 pounds and works with a power of 30,000 foot-pounds a minute? By rule 64 (III.)

$$v = \frac{30{,}000}{50} = 600 \text{ feet a minute.}$$

A Case of Spontaneous Combustion.

Having learned that the works of the Hoggson & Pettis Manufacturing Company, New Haven, Conn., were damaged by fire on Sunday, August 17, the fire resulting from spontaneous combustion, and knowing the interest of manufacturers in fires of this kind, we wrote the firm for particulars, and received the following in reply:

"The fire in our works, August 17, occurred about 11:30 A. M., and was caused by the spontaneous ignition of some oily waste, thrown into the box which stands in the boiler-room to receive the odds and ends of wood and paper which accumulate during the day, and which were not burned by the engineer on Saturday, as is his custom. We provide an iron can into which the old waste throughout the factory is collected and thrown, and then burned. A hand from some department failed to follow orders, and the fire resulted.

"Over the box in which the fire started, about ten or twelve feet, is a belt-shoot leading to our new forge shop. The belt used, and which we had just started two or three days before, was an 8 inch double belt, 170 feet long. The heat in the boiler-room rushed out through this enclosed shoot, and drew the flames up to the woodwork, and the belt, being waterproof, seemed to be quite inflammable and fed the flames till they reached the floor above. They ran along the belt-shoot into the forge shop, which luckily had an iron roof, saving that building from destruction, probably.

"The engine-room being separated from the boiler-room by a brick wall and tinned doors, the fire failed to damage the engine at all, and we are running as usual. Our large stock of Sweetland chucks is kept in another building, and we shall not be hampered in any way in filling orders.

"We are now working more hands than ever before in our chuck department, and had the fire gained headway there it would have crippled us badly. As it is, the prompt service of our fire department saved us from what might have been serious loss."

At the naval exhibition to be held next year at Chelsea, England, it is the intention to exhibit everything going to show the past history of the British navy, as well as its present state.

Machinists' Supplies and Iron.

NEW YORK, August 23, 1890.

Iron—American Pig—There has been no change of importance during the week, the demand for current consumption remaining very good for this season of the year, and contract deliveries absorbing a very large proportion of the output of standard brands. The prices for these brands are steadily maintained, though occasionally a lot of some other brands is sold at some concession. Upon the whole the condition of the market is considered to be exceptionally good for this season of the year, when no great activity is expected. The demand for finished iron continues good.

We quote Northern No. 1 Foundry, $17 to $18; No. 2, $16 to $17; Grey Forge, $15 to $15.25; Southern No. 1, $16.50 to $17.25; No. 1, Soft, $16.50 to $16.75; and No. 2, $15.75 to $16.

Scotch Pig—The market has continued to rule quiet and steady, with no change of prices worthy of note.

We quote Eglinton, $19.25 to $19.75; Dalmellington, $21 to $21.50; Coltness, $23.50 to $24.

Bar—The demand has been moderately good, and prices are without quotable change.

We quote Common, $1.85; Medium, $1.90; Refined, $1.95 to $2 for round lots on dock.

Copper—The market has been without special features, and has ruled quiet and steady. Lake Ingot is being sold for near delivery at 17c.; casting brands are held at 14¼c.; Arizona at 15¼c.

Lead—Speculative operations have advanced quotations slightly, though consumers do not show any increased interest, and evince no disposition to supply themselves with stock. Values are at about 4.60c. to 4.61¼c.

Spelter—The demand for Western has been moderate and the market has ruled quiet and steady. We quote ordinary brands, Western 5.45c. to 5.55c. Choice 5.70c. to 5.75c. Refined 6.75c to 7c. Silesian 7c. to 7.50c.

Tin—Prices have advanced in London, and a little more interest is shown here in consequence. Values range from 21.15c. to 21.50c.

Antimony—There has been no change worthy of note.

We quote Hallett's, 20½c. to 20¾c.; Cookson's, 23½c.

Lard Oil—The demand has been fairly good, and prices are unchanged at 49c. to 50c. for prime.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted--A first-class, experienced mechanical draftsman. Inquire 151 Cedar street, New York.

Wanted—Position by mech. draftsman, references. B., Box 165, Times Office, Hartford, Conn.

Wanted—Situation as foreman of pattern shop by a practical man; good ref. Box 66, AM. MACH.

Wanted—Irregular die makers. Address Ferracute Machine Co., Bridgeton, N. J.

Wanted—Exp'd foreman for machine shop. Address, with particulars, W., 116 S. Clinton st., Chicago.

Wanted—One or two first-class machinists. Apply at 151 Cedar street, New York.

Foreman of iron foundry is open to an engagement. Experience in all kinds of work. Address G. Z., AMERICAN MACHINIST.

Wanted—Draftsman, engine work. Give age, experience, wages, and particulars. Morris County Machine & Iron Co., Dover, N. J.

Mechanical engineer and draftsman, with ten years experience in designing steam engines and general machinery, wishes to change. Address Box 63, AM. MACHINIST.

Wanted—As foreman, an experienced and practical man in the manufacture of milled machine screws, etc., for shop in Canada. State salary; references required. Address Box 62, AM. MACHINIST.

Wanted—Good machinists; vise or machine hands; steady work and good wages to first-class men. Address Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—Superintendent for Architectural Iron Works with executive ability and experience. State reference and experience. A mechanical engineer preferred. Apply to S. H. Parvin's Sons, Cincinnati, O.

Wanted—By a gentleman about to open a manufacturers' agency, correspondence with manfrs. desirous of being represented in Canada; security given. D. W. C., 307 Sherbourne street, Toronto, Canada.

Machinists Wanted—First-class floor hands and fitters of large experience and of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, O.

Wanted—Machinists and metal pattern makers; a steady employment given to capable men; works are being greatly enlarged; town near Chicago, is rapidly growing and has an excellent climate. Haxtun Steam Heater Co., Kewanee, Ill.

Wanted—Fifteen or twenty experienced molders, to make heavy and light castings; state experience, habits, age, and class of work preferred. Steady employment to good men. Address The Canton Steam Pump Co., Canton, Ohio.

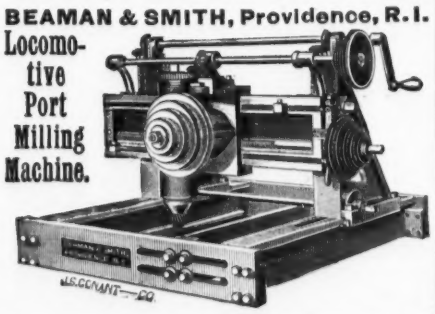
Wanted—A foreman for Blacksmith and Hammer Dept's, at Pittsburgh Locomotive Works, Pittsburgh, Pa. Must be temperate and thoroughly understand the business. State wages expected, and address applications to the Company.

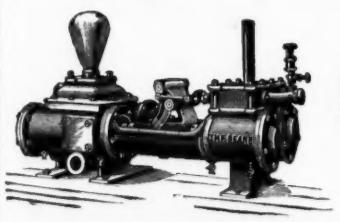
Wanted—Vise hands and fitters on turret lathe work. Steady work to A1 workmen of good habits; new shop with modern tools and sanitary arrangements. Jones & Lamson Machine Co., Springfield, Vt.

Wanted—To add to office force in large shops in Chicago, one or two draftsmen experienced in Corliss and general engine designing, also one or two draftsmen experienced in mill building, constructions and general machinery. Address Box 40, AMERICAN MACHINIST.

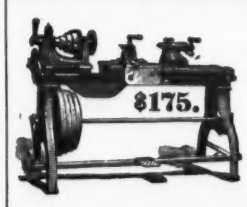
BRADLEY HAMMERS AND FORGES
BEST HAMMERS IN THE WORLD RUN BY BELT
OVER 1500 IN USE.
Three Styles, 15 lb. to 500 lb. Heads.
Our FORGES heat irons fast enough to keep Hammers and Men fully employed. Send for Catalogue and Prices.
BRADLEY & CO., SYRACUSE, N. Y.
14 WARREN ST. NEW YORK. 96 & 98 SUDBURY ST. BOSTON.

BOILER MAKING
FOR BOILER MAKERS.
A practical treatise on work in the shop, showing the best methods of Riveting, Bracing, and Staying, Punching, Drilling, Smithing, Etc., and the most economical manner of obtaining the best quality of output at the least expense.
By W. H. FORD, M. E.
18mo, Cloth, - - - $1.00.
Published and For Sale by
JOHN WILEY & SONS, 53 E. 10th St., New York.
Mailed and prepaid on the receipt of the price.

BEAMAN & SMITH, Providence, R. I.
Locomotive Port Milling Machine.



THE DEANE
OF HOLYOKE
STEAM PUMPS
DEANE STEAM PUMP CO.,
HOLYOKE, MASS.

BEST STEEL
For Taps, Dies, Punches, Milling Cutters, Lathe and Planer Tools, Cold Chisels, Edged Tools and Hardware of all kinds.
CRESCENT STEEL CO.,
136 FIRST AVE., PITTSBURGH, PA.
64 & 66 So. CLINTON ST., CHICAGO, ILLS.
180 PEARL STREET, NEW YORK, N. Y.



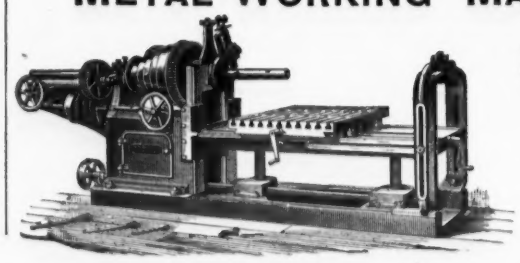
Improved Screw Cutting Foot and Power LATHES
Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.
THE SEBASTIAN-MAY CO., 167 W. 2d St.,
CINCINNATI, O.
MONTGOMERY & CO., 105 Fulton St., New York, Gen'l Agents.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.

TOBIN BRONZE
Tensile Strength upwards of 79,000 lbs. per sq. in.
Torsional Strength equal to the best Machinery Steel.
Anti-Frictional and Non-Corrosive.
CAN BE FORCED HOT.
Rods for pumps and bolts. Yacht shafting. Rolled sheets and plates for pump linings and condenser tube sheets, &c. Spring wire.
ANSONIA BRASS & COPPER CO.,
Sole Manufacturers,
Send for Circular.
CHICAGO. NEW YORK.

GEO. F. BLAKE MANF'G CO.
BUILDERS OF EVERY VARIETY OF

95 & 97 LIBERTY ST., NEW YORK. 111 FEDERAL ST., BOSTON.
WATER WORKS PUMPING ENGINES A SPECIALTY

BETTS MACHINE CO., WILMINGTON, DEL.
MAKERS OF
METAL-WORKING MACHINE TOOLS
FOR
Locomotive, Bridge & Engine Builders, Railroad, Car & Machine Shops
AND
Iron and Steel Works Generally.


Wanted—Situation as master mechanic or foreman of a machine shop. Occupying a position as master mechanic at present. Understand steam engine and pump work, drawing, designing and estimating. Strictly temperate. Address C. W. Riley, Knoxville Car Wheel Co., Knoxville, Tenn.

Wanted—A competent machinist to do light accurate work on the lathe or vise as required; must be steady and reliable. To the right man will be offered a good place in a comfortable shop doing a variety of work. Address "Machinist," care Am. Machinist.

Wanted—Foreman for our pattern shop, a pattern maker who is master of his trade, who has a good education and a thorough understanding of drawings, and who has had experience in architectural iron work; a permanent position and a good salary to a competent man. Address The Snead & Co. Iron Works, Louisville, Ky.

Wanted—Superintendent to take charge of a small shop in England; must thoroughly understand manufacture of small lathes and milling machines on proper system. Good tools (American) and every facility. Permanent situation to really first-rate man. Apply with full particulars of experience and salary required, to Alfred Herbert, Grosvenor Road, Coventry, England.

Wanted—About 50 machinists of all branches. Wages for skilled men from 25 to 30 cents per hour, according to ability. Piece-work rates enable a good man to earn one-third more. Steady employment to reliable men. Shops exceptionally comfortable to work in. All workmen paid weekly. An Aid Society, fostered by the company, assists its employes in case of sickness or accident. This establishment in past years has furnished steadier employment to its workmen than any other in Western Pennsylvania. Good boarding at moderate rates will be provided for those who desire it, or are not acquainted in Pittsburgh. Further information may be obtained by calling at this company's agency in New York, 17 Cortlandt street, or by applying in person or by letter to The Westinghouse Machine Company, corner of Liberty and Twenty-fifth streets, Pittsburgh, Pa.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d-hd lathes & planers. S M York, Clev'd, O.

Koopman's Scales for quick measurements.

Cheap wire rope for power. S. M. York, Clev'd, O.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

For Sale—Old established paying foundry and machine shops; whole or half interest. Address L. M. Newbury, Sparta, Wis.

Wanted—To contract for 6,000 door-lock castings without delay. Write to S. Heberling Novelty Works, 88 East Walnut street, Des Moines, Iowa.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

Wanted—Cheap for cash, a second-hand screw cutting foot lathe in good condition. Address, giving particulars and lowest price, W. R. Anderson, Box 43, Rondout, N. Y.

For sale—Whole or part of foundry and machine works in good town in Indiana gas regions; good buildings, suitable for any kind of manufacturing. T. M., 9 Whippo street, New Castle, Penn.

Wanted—Engineers to write for Catalogue of all the latest and most valuable mechanical, scientific and electrical books which are given free with each barrel of the Pittsburgh Boiler Scale Resolvent. Pittsburgh Boiler Scale Resolvent Co., Pittsb'gh, Pa.

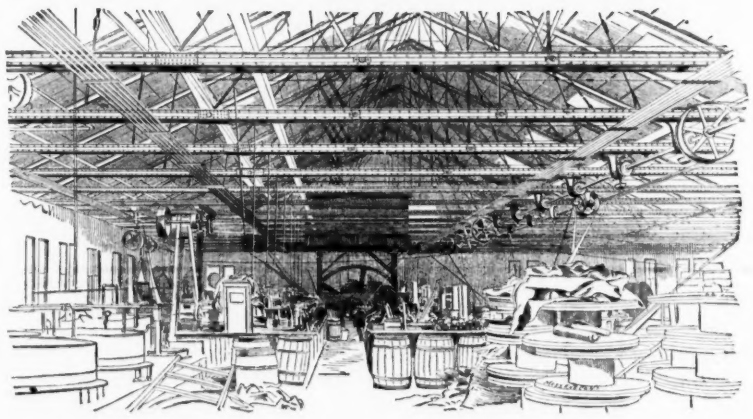
Wanted—Complete designs of Corliss types of engines, sizes to be designated by us, and having valve gear of the automatic cut-off type that will not conflict with those adopted by other builders. Address Box C, West Duluth, Minn.

Wanted immediately—One first class tool-room lathe, 20" swing, 4' between centers, with tapering attachment; state maker's name and price; also, want a good pit lathe, to swing 30'. Address Fraser & Chalmers, Fulton and Union streets, Chicago.

NICHOLSON FILE COMPANY,
PROVIDENCE, R. I.

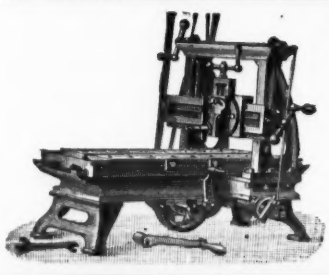
FILES AND RASPS
FOR EVERY VARIETY OF WORK.

THE BERLIN IRON BRIDGE CO.
Office and Works: East Berlin, Conn.



The above cut is taken direct from a photograph of an iron roof built by us for the Seymour Mfg. Co., at Seymour, Conn., and covers one of the finest Rolling Mills in the Naugatuck Valley. The building is 160 ft. in width, divided into two spans of 80 ft. each and 200 ft. long. The trusses are pin connected, are made to carry shafting, and are also made of sufficient strength to lift the rolls in and out of the housings.

SEND FOR OUR ILLUSTRATED CATALOGUE.



SMALL POWER OR HAND PLANER.
FOR ANY SMALL WORK.

Weight of Platen 100 lbs.

A. J. WILKINSON & CO.,
184 Washington St., BOSTON, MASS.

SEND FOR CIRCULAR.

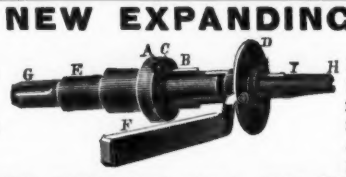
LECOUNT'S NEW EXPANDING MANDREL.

Amateur's Size.

Taking anything from ⅛ to 1 inch inclusive.

Price $5.00

Patented Dec. 25, 1877.



Machinist's Size.

No.			Price.
1	⅛ to 1	in.	$10
2	1	" 1½ "	14
3	1½	" 2 "	18
4 (with screws)	2	" 3 "	32
5 "	" 3	" 4 "	44

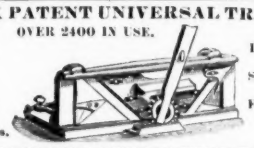
IF YOU WILL TRY THIS TOOL YOU WILL NOT REGRET THE EXPENSE.
C. W. LECOUNT, SOUTH NORWALK, CONN.
SPECIAL MANDRELS FOR SPECIAL JOBS MADE TO ORDER.

JESSOP'S STEEL
For TOOLS, DRILLS, DIES, &C.
All Kinds in Stock.
Gold Medal, Paris, 1889.

MANUFACTORY,
WILLIAM JESSOP & SONS, L'D. | SHEFFIELD, ENGLAND. | Chief American Office, 91 JOHN ST., NEW YORK.

THE FOX PATENT UNIVERSAL TRIMMER
OVER 2400 IN USE.

ORIGINAL
Saves Time,
Three Sizes,
Four Styles.



IMPROVED
Saves Money
From New
Patterns.

NO PATTERN ROOM COMPLETE WITHOUT THEM.
Send for Circular. Beware of infringements.
THE FOX MACHINE CO., 325 North Front St., Grand Rapids, Mich.

—Novelty Patent Hand Drill.—
A new, ingenious and handy tool for drilling small holes, running at any speed desired. Operator can handle the work with one hand, and the drill with the other.

TINIUS OLSEN & CO.
Mfrs. Testing & Hydraulic Mach'y,
Twelfth and Buttonwood Streets,
PHILADELPHIA, PA.

SEND SAMPLE.
We make a specialty of all kinds of screw machine work and do it cheaper than you can.
WRITE FOR PRICES.
BLAUVELT & HALDY,
Factory Pearl & Front Sts., Brooklyn Office, No. 258 Broadway, N. Y.

FITCHBURG
Machine Works,
Manufacturers of
METAL-WORKING MACHINES.
Office and Works,
13 to 21 Main Street,
FITCHBURG, MASS.
SEND FOR CATALOGUE (E.)

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS.
810 Walnut St., Philadelphia.

☞ Our New and Revised Catalogue of Practical and Scientific Books, 80 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

SUFFOLK, VA.,
The Railroad Key of Eastern Virginia.

NOT A BOOM—
A HEALTHY GROWTH.

THE EAST SUFFOLK LAND CO.,
OF SUFFOLK, VA.

OFFICERS:
SKIPWITH WILMER, President, Baltimore.
J. W. MIDDENDORF, Treasurer, Baltimore.
CHAS. H. JONES, Jr., Secretary, Suffolk, Va.
BARTON & WILMER, Attorneys, Baltimore.
WHITE & GARNETT, Attorneys, Norfolk, Va.

DIRECTORS:
JOHN GILL, *President Mercantile Trust and Safe Deposit Co., Baltimore.*
H. IRVINE KEYSER, *Director Farmers' and Planters' Bank, Baltimore.*
C. H. CAUSEY, *Attorney, Suffolk, Va.*
J. W. MIDDENDORF, *Middendorf, Oliver & Co., Bankers, Baltimore.*
JACOB HECHT, *Capitalist, Baltimore.*
MAX GREIF, *Wholesale Clothier, Baltimore.*
CHAS. H. JONES, Jr., *Vice-President Suffolk & Carolina Railway Co., Suffolk, Va.*

The property of the Company embraces 940 acres of land bordering on the Eastern and Southern Limits of Suffolk, is admirably located and has a natural drainage which gives it a special advantage for residence or business property.

Suffolk is the natural railroad center of Eastern Virginia. It has six railroads, three lines of steamers, public schools, banks and churches, water works, and a fire department, in fact all the appointments of a live and progressive city. There are already established and in successful business, Manufactories of Wooden Ware, Wooden Butter Dishes, Veneers, etc., Saw and Planing Mills, Kindling Wood Factories, Iron Works, Packing Establishments, Brick Factories, Carriage Factories, etc., besides the projected enterprises - a large Iron Working Establishment, a Peanut Factory, an Ice Factory, a Chair Factory, a Barrel Factory, and various minor industries. And still there's room, opportunity, territory and success for all kinds of manufacturing enterprises.

Substantial encouragement given to all enterprises employing a certain amount of labor.

For full information relative to inducements offered, manufacturing or residence sites, address or call on

CHAS. H. JONES, JR., SECRETARY,
EAST SUFFOLK LAND CO., SUFFOLK, VA.

BUFFALO FORGES.
BUFFALO FORGE CO., BUFFALO, N. Y.

BABBITT METAL
Cooke & Co.'s Special Brands.

ACME, for high speeds and heavy work.
SUPERIOR, for jobbing and general use.
RELIABLE, for shafting bearings for ordinary service.

Write for prices or send us a sample order.

COOKE & CO.,
22 CORTLANDT ST., NEW YORK.

SHARTLE'S
BULL DOG.

THE HARDER YOU PULL, THE TIGHTER IT HOLDS.

CLASS "B."
This style is made for general machine shop use from 1 3-4 in. to 8 in. or larger. Can't slip. No wrench required, and satisfaction guaranteed. Write for catalogue showing the different styles. MANUFACTURED BY
The Middletown Machine Co., Middletown, O

THE BRITISH & EUROPEAN PATENT AGENCY,
F. W. Barker, Manager, (Registered English Patent Agent, According to Act of Parliament,)
252 Broadway, New York.
151 Strand, London, Eng.

American and European Patents obtained at equitable rates. *Special Facilities for Sale of Foreign Patents through our London House. A good invention is worth as much in Great Britain as in the U. S.* Competent draftsmen employed on premises. We refer to well-known men in the machine trades for whom we have done business. Send for Circular.

"Star" Foot Lathe Swings 9x25 in.

LATHE

Screw Cutting Automatic Cross Feed, etc.

Scroll Saws, Circular Saws, Lathes Mortisers.

Catalogue Free of all our Machinery.

Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y.

WORTHINGTON
STEAM PUMPS

SEND FOR NEW EDITION OF GENERAL CATALOGUE

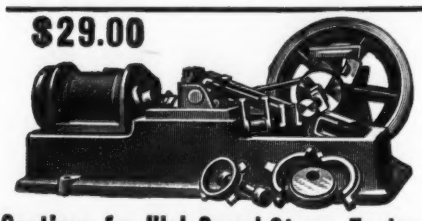
HENRY R. WORTHINGTON
88 LIBERTY STREET
NEW YORK

Established in 1874.

CLEVELAND TWIST DRILL CO.

Corner Lake & Kirtland Sts., Cleveland, O.
101 Chambers Street, New York.
85 Queen Victoria St., London, Eng.

$29.00



Castings for High Speed Steam Engine.

CYLINDER, 4 in. x 4 1-4 in.

T. SHRIVER & CO., IRON AND BRASS FOUNDERS,
333 E. 56th St., N. Y. City.

Sets of Castings for Engine illustrated above, with *Cast-steel Shaft, Connecting Rod* and *Rock Shaft* and *Brass Bearings*, boxed and shipped on receipt of $29.00. Three sheets *blue prints* of working drawings, extra.

STEAM

PARK Double Jet INJECTOR

WATER

TO THE BOILER

PARK MFG. CO.,
53 Portland Street,
Boston, Mass.

THE most reliable under varying steam pressure of any injector known. Will work from 15 pounds to 180 pounds without any adjustment. The only **Automatic Injector** that will thoroughly drain itself when shut off, thus preventing freezing. *Every Machine Guaranteed.*

INJECTORS AND JET APPARATUS.

WELDLESS STEEL TUBES COLD DRAWN

QUICK OPENING GATE VALVE.

SMOOTH INSIDE & OUT.

JOHN S. LENG,
4 Fletcher St. N.Y.

PAT'D JUNE 4TH 1889

THE KEYSTONE HANDLE.

A permanent and reliable method of attaching Hammers and all Edge Tools to Handles. Address,

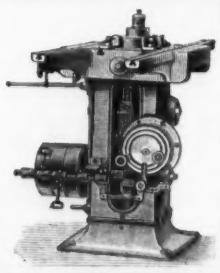
E. H. BROOKS, LEBANON, PA.

Bolt and Nut Machinery.

SECOND-HAND TOOLS
For Sale Cheap.

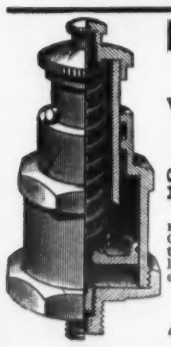
1" Acme Bolt Cutter, old style frame.
No. 4½ Schlenkler Bolt Cutter (old style), cuts to 1¾"
No. 5 Schlenkler Bolt Cutter (new style), cuts to 2"
Double Schlenkler Bolt Cutter (new style), cuts to 7/8"
Double Lewis, Oliver & Phillips Bolt Cutter, cuts to 1½"
National Double Rapid Bolt Cutter (old style frame).
3-Spindle Belt Nut Tapper.
6-ft. Compound Shaper (double tables).
12" Crank Planer.
Durfee & Doe Key Seating Machine.

The NATIONAL MACHINERY CO.,
TIFFIN, OHIO.



KEY SEATERS
PORTABLE AND STATIONARY.
RACK-CUTTING AND KEY-MAKING ATTACHMENTS.

Giant Key-Seater Co.,
EAST SAGINAW, MICH.



LACKAWANNA GREASE CUP

Will Save its Cost in Oil alone Several Times per Annum.

SAVES ALSO IN LABOR AND COST OF COTTON-WASTE, PREVENTS DRIPPING AND SPATTERING.

A POSITIVE FORCE FEED with the most PERFECT REGULATION and GREATEST CONVENIENCE in operation yet attained in any device for the lubrication of machinery. Works equally well in every possible position.

Lackawanna Lubricating Co.,
41 Coal Exchange, Scranton, Pa

SOME NOTABLE ARTICLES

APPEARING IN BACK ISSUES OF THE

AMERICAN MACHINIST.

The following list is published to facilitate the ordering of back numbers containing them. Any of these issues can be ordered through any newsdealer, or of the publishers direct, at the price then ruling, viz.: 5 Cents a Copy.

1886.

Pattern Making. Various Articles on. By F. W. Barrows. Appearing in 29 issues.
Foundry Practice, Various Articles on. By Robt. E. Masters, appearing in 16 issues.
Strength of Different Mixtures of Cast iron and Method of Testing. By Robt. E. Masters, April 24.
Foundry Practice, Articles on. By Foundryman. [L. C. Jewett.] Aug. 14, Sept. 25, Dec 18
Foundry Practice, Articles on. By S. Bolland. May 8, 22 29, June 26 July 10.
The Morton-Poole Roll Grinding Lathe. By Joshua Rose, J. G. Tramis, Geo. H Babcock and C. A. Smith. July 3, 24, Aug. 7, 14, 21, Sept. 25.
Machine Shop Cost and Time Accounts. By A. J. Shaw, Henry Metcalfe and C. A. Burton, April 3, 17, May 8.
Tests of Iron. By David Spence, April 17, Oct. 30
Traction on Grades. By A. B. Ropes, Oct. 30.
Wilson's Valve Gear for Locomotives, Oct. 30.
Casting Face-plates Face Up. By David Spence, Oct. 23.
A Job of Shaft Straightening. By F. L. Johnson, Oct. 23.
Inventory Valuation of Machinery Plant. By Oberlin Smith, Aug. 7.
Making a Cast iron Sheave. By P. S. Dingey, July 31.
New Dredge Boiler designed by Norman Wheeler, July 17.
Core Oven with Rotating Back. By Thos. Wathey, July 24.
Universal Table for Lathe Change Gears for Screw Cutting. By Joshua Rose July 24.
Gating, Clamping and Securing Chaplets By Matthew Wiard, May 1.
Printing Frame and Manner of Making Blue Prints. By C. L. Redfield, July 31.
Some Pressure Tests. By C O Sine, Nov. 27.
An Expanding Mandrel—Turning Tapers. By Chas. S. Beach, Nov. 27.
Core Making in Foundries. By David Spence, Nov 20.
Making Pattern for Spiral Grooved Drum. By Geo. Allge, Aug. 14
Rolling Conic Sections Applied to Gears. By Geo B. Grant, Nov. 6.
Ninety-inch Belpaire Fire-box Boiler, Nov. 6.
Spacing in the Milling Machine. By Chas. S. Beach, Aug. 21.
Engine Crossheads. By J. G Tramis, Aug 21
Traction and Adhesion. By A. B Ropes Aug. 2
Internal Key-seating on Milling Machines. By A. B Landis, April 17.
Tapping Holes in Boilers. By A. B. Landis. April 24.
How to True Emery Wheels. By L Best Apr 24.
Work and System in the Drawing-room By C L. Redfield, Aug. 28.
Oiling Lathe Carriage Ways By Wm. H. Bradt, Aug. 28.
Moulding a Screw or Worm without Cores By George Allge Sept 11, 18.
Power Absorbed in Cutting Cast-iron By James F. Hobart. Sept. 11, 18.
Moulding Screw Propellers in Loam. By Chas. A. Devlin, Sept. 18.
Dimensions of Wrought iron Pipes in England. By A G. Brown, Sept 4.
Truing Up and Replacing Milling Machine Centers with Accurate Alignment. By A. B. Landis Jan. 16.
Methods of Working and Tempering Steel. By S. W. Goodyear, Jan 9.
Slotting Tool. By J. J. Bingley, May 8.
How to Make Clean Solid Castings at Least Possible Cost. By Matthew Wiard, April 10.
Truing Milling Machine Centers. By W. R. Ballou, April 10.
Lining Engine Lathes. By Chas. S. Beach, April 10.
Steam Piping. By J. G. Tramis, April 10.
An Equalizing Dog. By A. B. Landis, April 10.
Screw Cutting Dies. By John J. Grant, April 10.
Some Handy Shop Tools. By Fred. H. Colvin, April 3.
Moulding Bells for Blast Furnaces in Green Sand Without Patterns. By Geo. O Vair, April 3
Furnace for Heating Long Bars. By W. G. Richards, April 3.
Cutting Tools—Roll Turning. By S. W. Goodyear. Oct. 16.
Hydraulic Forging. By J. Richards, July 10.
A "Box" Jig. By C E. Simonds, June 19.
Cheap Testing Machine. By Wm. Merrill, Feb. 6.
Boring Deep Holes. By A B. Landis, Mar 2 May 8.
Working Steel and Iron. By S. W. Goodyear Feb. 13.
Inventory Valuations of Patterns. By W. E. Mathe son and others, Jan. 9, Feb. 13, 20, Mar. 6
Making Cast-iron Half Boxes. By A. J. Shaw. Feb. 6.
Draining Steam Pipes. By W. E. Crane Feb. 6.
Brazing and Welding Iron. By J. F. Hobart, Mar. 6.
Deep Holes by Continuous Boring. By A. B. Landis, Mar. 27.
Slotting Machine Tool. By Wm. Foster, Mar. 20
Compound Engines for Stationary or Factory Purposes. By W. H Hoffman, April 24, May 1, 22.
Engineering Subjects, Articles on. By W. H. Hoffman. Mar. 13, July 24, 31, Aug. 21, Oct. 9.
Self-contained Engines. By W. H. Hoffman, Feb. 27, Mar. 6.
Curving Qualities of Locomotives with High and Low Centers of Gravity, Oct. 16.
Making Large Spur Gear Wheels. By P. S. Dingey, Oct. 2.
Normal Theory of the Gear Tooth Curve. By Geo. B. Grant, Mar 13, 20 Oct. 9.
Return Tubular Boilers. By Wm. Lowe, Nov. 27, Dec. 4.
Chimneys for Steam Boilers. By Wm. Lowe, Mar. 27, May 15. By F. A. Halsey, May 1.
Railroad Cost Cards and Expense Sheets, April 24
The Milling Machine—Its Construction and Uses. By John J. Grant, Mar. 20.
Mechanical Arrangements of the N. Hudson County Cable Railway, Mar. 20.

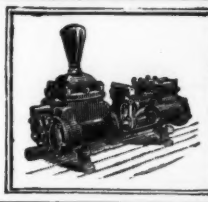
HALL DUPLEX STEAM PUMPS.

Send for 1890 Catalogue.

Fire Pump.

HALL STEAM PUMP CO.,
91 LIBERTY ST., NEW YORK.
PITTSBURGH. CHICAGO. ST. LOUIS.

Boiler and Pump Combined.



THE BUFFALO STEAM PUMP CO.
BUFFALO, N.Y. — MANUFACTURERS OF
STEAM PUMPS
FOR ALL DUTIES.

Maslin's Patent Steam Pump.
Pat. Feb. 12, & Dec. 3, '89.

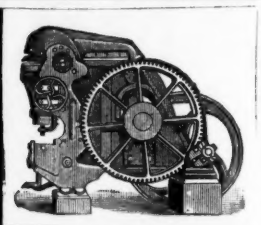
Cheapest and Best Automatic Steam Vacuum Pump. Handling DIRTY and GRITTY LIQUIDS without Wear, Oil or Care. Simple, Economical, Efficient & Durable. Pumping Plants for Contractors, Irrigation, Water Works, Railroads, Mining & General Hydraulic Purposes. Write or call for Circulars. JOHN MASLIN & SON, SOLE MANUF'RS, 165-167 1st St., Jersey City, N. J.

COMPLETE STEAM PUMP
10 SIZES FROM $7 TO $75
FOR WATER SUPPLY TANKS, FIRE PUMPS & ETC.
WRITE FOR PRICES AND DESCRIPTIVE CIRCULARS
VAN DUZEN & TIFT
SOLE MAKERS
CINCINNATI, O. U.S.A.

FRICTION CLUTCH PULLEYS AND CUT-OFF COUPLINGS

JAS. HUNTER & SON,
North Adams, Mass.

PUNCHING AND SHEARING MACHINERY
AND BOILER MAKER'S ROLLS.
NEW DOTY MANUFACTURING CO.
JANESVILLE, WISCONSIN.



CRUCIBLE AND OPEN HEARTH
CAMERON SELF-HARDENING
STEEL

ESTABLISHED 1859.

HOWE, BROWN & CO., L't'd, Mfrs., Pittsburgh, Pa.

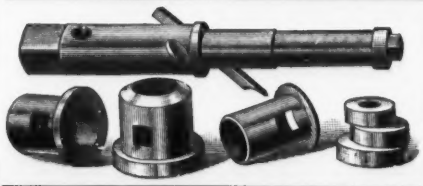
BRANCH OFFICES: 12 Cliff St., New York. 127 Oliver St., Boston. 228 Lake St., Chicago.

All GENUINE INGOTS & MANUFACTURES BEAR OUR REG. TRADE MARKS.

"Phosphor-Bronze."

PHOSPHOR-BRONZE
INGOTS, CASTINGS & MANUFACTURES.
THE PHOSPHOR BRONZE SMELTING CO. LIMITED
512 ARCH ST. PHILADELPHIA PA. U.S.A.
ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND OWNERS OF THE U.S. PATENTS.

PATENT OILERS, CYLINDER SIGHT FEED CUPS.
Government Regulation
POP SAFETY VALVES,
For Stationary, Marine and Locomotive Boilers.
J. E. LONERGAN & CO., BRASS FOUNDERS AND FINISHERS,
211 Race Street, Philadelphia, Pa.
1888 CATALOGUE FREE ON APPLICATION.



—THE—
Vance Lightning Flue Cutter

For removing Flues from Locomotive and Stationary Boilers. One man can cut five hundred (one end) in a day. In use in the leading Railroad Shops of the country. Combination Cutter for removing 2 in., 2 1-4 in., 2 1-2 in. and 3 in. flues, $50. Sent on approval to Railroad Co's. Liberal Discounts to the Trade.

VANCE TUBE CUTTER CO., Geneva. N. Y

UNIVERSAL RADIAL
RADIAL DRILLING MACHINES
THREE DESIGNS, SIX SIZES.
EMBODY ALL DESIRABLE FEATURES
PRICES $450.00 & UPWARD
ADDRESS UNIVERSAL RADIAL DRILL CO
CINCINNATI, O. U.S.A.

BRASS GOODS,
For Water, Steam and Gas. Brass and Composition
CASTINGS
to order. Pattern and Patent Brass Work a specialty.
W. S. WILLIAMSON,
36 to 40 Penn Street, BROOKLYN, N. Y.

ROOTS' NEW ACME HAND BLOWER.
For Blacksmiths, etc. Slow Speed, Positive Blast. Is Durable, Compact and Cheap; also Portable Forges, Tuyere Irons and Foundry Blowers.

P. H. & F. M. ROOTS, Mfrs.
CONNERSVILLE, IND.
S. S. TOWNSEND, Gen. Agt., } 22 CORTLANDT ST., NEW YORK.
COOKE & CO., Selling Agts., }
Please Mention This Paper.

BEVEL GEARS,
Cut Theoretically Correct.
For particulars and estimates apply to
HUGO BILGRAM,
MACHINIST,
Successor to
BREHMER BROS.,
440 N. 12th St., Philadelphia, Pa.

American Standard Gauge & Tool Works,
WILMINGTON, DEL.
Makers of Implements for Standard Measurements.

Crescent Gauge.

Over 43,900 in Use.

Flat Bar Gauge.

JAS. A. TAYLOR & CO.

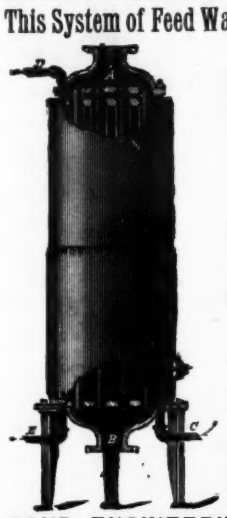
Boilers for carrying 150lbs. Pressure

WITH LEAST POSSIBLE DANGER
PROMPTLY FURNISHED BY AND HIGHEST ATTAINABLE ECONOMY

HARRISON SAFETY BOILER WORKS,
Germantown Junction, Philadelphia, Pa.

NEW YORK, N. Y. 41 Dey Street. | CHICAGO, ILL. 6 So. Canal Street. | ATLANTA, GA. 9 No. Pryor Street. | MINNEAPOLIS, MINN. 421 Guaranty Bldg.

This System of Feed Water Heater is the Best



AND THE

LOWE

is the simplest
HEATER
on the System.
Has Straight Tubes
With reliable provision for expansion, and will
HEAT AND PURIFY THE WATER
EQUAL TO ANY
With same Feet of Heating Surface and
Wear the Longest.
Send for description and Histories of Boilers and Feed Water Heaters to
Bridgeport Boiler Works
Bridgeport, Conn.

POND ENGINEERING CO., AGENTS,
ST. LOUIS, CHICAGO, KANSAS CITY, OMAHA.

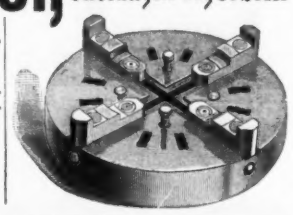
ESTABLISHED 1842.
ROBERT POOLE & SON CO.
ENGINEERS AND MACHINISTS.
MACHINE MOULDED GEARING.
ALL KINDS OF TRANSMISSION MACHINERY
OF THE HEAVIEST CLASS.
BALTIMORE, MD.

WESTCOTT CHUCK CO., Oneida, N.Y., U.S.A.

MANUFACTURERS OF
LATHE and DRILL CHUCKS.
SEND FOR ILLUSTRATED CATALOGUE.

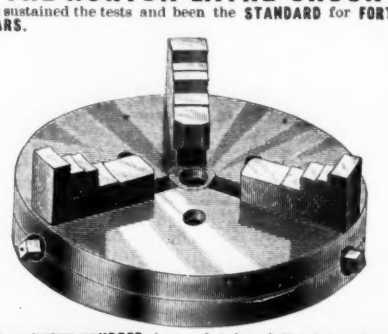
Independent Chucks.
Jaws Reversible.
Four Jaws.

Diameter.	Capacity.
7⅛ inch.	7⅛ inch.
10⅜ "	10⅜ "
13 "	13⅛ "
15¼ "	17 "
18 "	19¾ "
21 "	25½ "
24 "	28 "



Hydrostatic Machinery
PRESSES,
PUMPS,
PUNCHES,
ACCUMULATORS,
JACKS,
VALVES,
FITTINGS,
&c., &c.
WATSON & STILLMAN,
204, 206, 208 & 210 E. 43d ST.,
NEW YORK.

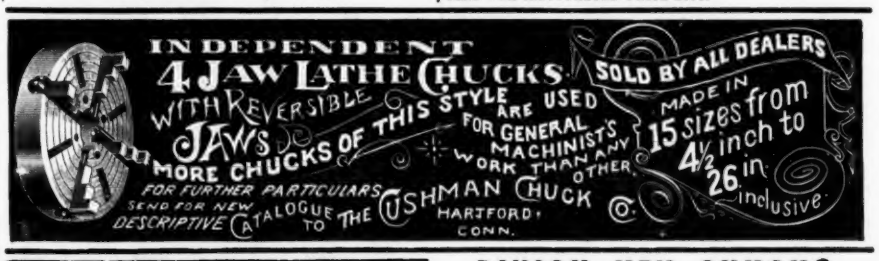
"THE HORTON LATHE CHUCK"
has sustained the tests and been the STANDARD for FORTY YEARS.

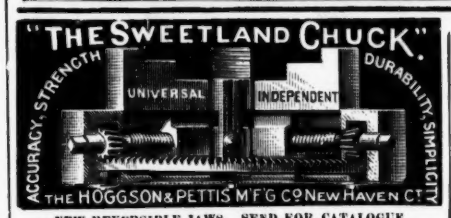


Over THREE HUNDRED sizes and styles of Chucks, made and kept in stock, by
THE E. HORTON & SON CO.,
WINDSOR LOCKS, CONN., U. S. A.
SEND FOR ILLUSTRATED PRICE LIST.

VOLNEY W. MASON & CO.,
Friction Pulleys, Clutches and Elevators,
PROVIDENCE, R. I.

Steam Boilers
FOR ALL PURPOSES,
POND ENGINEERING CO.
St. Louis, Mo.
SEND FOR CIRCULAR.


INDEPENDENT
4 JAW LATHE CHUCKS
WITH REVERSIBLE JAWS
MORE CHUCKS OF THIS STYLE ARE USED FOR GENERAL MACHINIST'S WORK THAN ANY OTHER.
SOLD BY ALL DEALERS
MADE IN 15 sizes from 4½ inch to 26 in. inclusive.
FOR FURTHER PARTICULARS SEND FOR NEW DESCRIPTIVE CATALOGUE TO THE
USHMAN CHUCK CO.
HARTFORD, CONN.

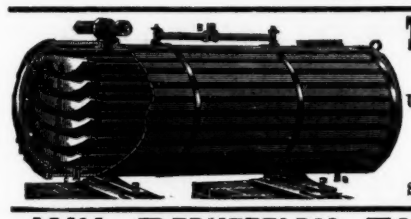


NEW REVERSIBLE JAWS. SEND FOR CATALOGUE.

PINION KEY CHUCKS.

A geared scroll chuck with the pinion on the key shaft. It has been used for years by the largest electrical and instrument factories in the U. S. It is warranted durable and true. Ask for it at your dealer's.

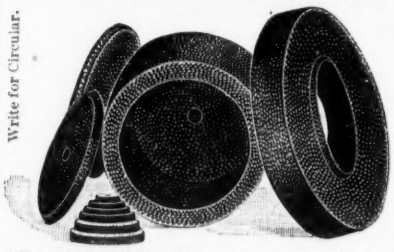
THE D. E. WHITON MACHINE CO.
No. 5 Oak St., New London, Conn.
S. A. SMITH, 23 S. Canal St., Chicago, Western Agt.



The HOPPES Live-Steam Feed-Water Purifier,
Guaranteed to Prevent Scale in Boilers.
Using any kind of water. Hard Sheet Steel Troughs.
Easily Cleaned.
HOPPES MANUFACTURING CO.,
Send for Catalogue D. SPRINGFIELD, OHIO.

THOS. H. DALLETT & CO.
1305 Buttonwood Street,
PHILADELPHIA, PA.
Portable Drills,
Hand Drills,
Boiler Shell Drills,
Light Drill Presses,
Special Machinery.
SEND FOR CATALOGUE.

EMERY AND CORUNDUM WHEELS.
EMERY WHEEL MACHINERY AND FLINT PAPER.
Write for Circular.



All goods manufactured by us are guaranteed to give satisfaction. Give them a trial on their merits.
Springfield Emery Wheel Mfg. Co., Successors to Springfield Glue & Emery Wheel Co., Bridgeport, Conn.
Western Branch, 18 & 20 West Randolph Street, Chicago, Ill.

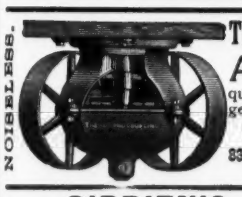
WM. BERKEFELD'S FOSSIL MEAL COMPOSITION.
The Only Genuine Fossil Meal.

The best non-conducting material known for Steam Pipes and Boilers. Can be easily removed and repeatedly reapplied.
ITS PLASTIC NATURE INSURES AN ABSOLUTELY TIGHT JOINT.
Requires less thickness than any other covering, and is therefore the CHEAPEST.
FOSSIL MEAL CO., 2 Cedar Street, N. Y.
A. GIESE, Proprietor.

Trade-mark. W. B. C.

CHARLES MURRAY
ENGRAVER ON WOOD
58 ANN ST. NEW YORK.

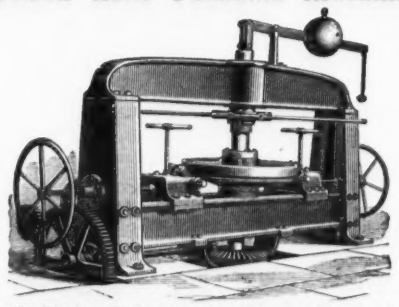
Steel Balls from 1/16 inch to 2⅜ inch for Anti-Friction Bearings a Specialty.
SEND FOR CATALOGUE.



The Almond Coupling
A NEW quarter turn motion to replace quarter turn belts and bevel gears.
T. R. ALMOND, MF'R.,
83 and 85 Washington Street,
BROOKLYN, N. Y.

SIMONDS ROLLING MACHINE CO.
TREASURER'S OFFICE
60 CONGRESS ST. BOSTON.
GEO. F. SIMONDS, PRESIDENT.
CHAUNCEY SMITH, VICE PRES'T.
EDWARD SAWYER, TREASURER.
JOHN J. GRANT, SUPERINTENDENT.
STEEL FORGINGS
by the SIMONDS patent process.
FITCHBURG, MASS. U.S.A.

O'BRIEN'S PATENT BOILER HEAD FLANGING MACHINE.

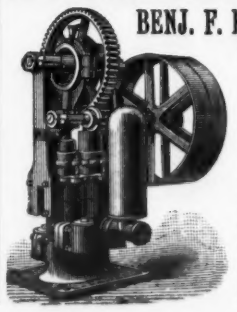


Rapid Work. Perfect Heads, with or without Dies. No Hole in Plate. Construction Simple. Price Reasonable.
JACOB CLARK, Mfr., Germantown, Philadelphia, Pa.

GRAPHITE
Plumbago
BLACK LEAD

Ground and prepared in quantities from ¼ lb. to a shipload. Lubricating Graphite a specialty. If you are at all interested in Graphite it will pay you to correspond with us, as different kinds are required for different purposes. All letters promptly answered.
Jos. Dixon Crucible Co.,
JERSEY CITY, N. J.

The Economic Boiler & Tank Feed-Pump

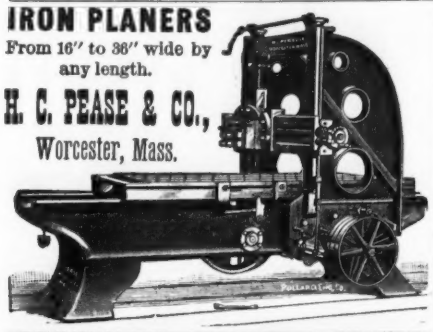


BENJ. F. KELLEY & SON,
91 Liberty Street,
NEW YORK.
It is a fact established beyond all dispute that the most economical of all methods of supplying steam boilers with feed water is by the use of a pump driven by a belt. The ECONOMIC PUMP is geared five to one. It is compact and systematic in design, and all parts are arranged for durability.

PATENT UNIVERSAL SCREW-CUTTING CENTER DEPTH ANGLE AND
J. WYKE & CO., TWIST DRILL GAUGE.
Fine Machinists' Tools.—E. Boston, Mass.—Send for Circular.

TOGGLE-JOINT DRAWING PRESSES. POWER SPRUE CUTTERS. ROTARY AND SQUARE SHEARS.
EMBOSSING PRESSES.
POWER PRESSES & DROP HAMMERS
BUTTON TOOLS.
FOR ALL KINDS OF SHEET AND BAR METAL.
DESIGNED AND BUILT BY
THE STILES & PARKER PRESS CO.,
MIDDLETOWN, CONN. 203-207 CENTRE ST., N. Y.
SPECIAL MACHINERY, DIES, TOOLS, ETC., ETC., MADE TO ORDER.

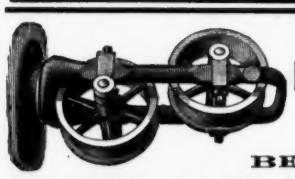
IRON PLANERS
From 16" to 36" wide by any length.
H. C. PEASE & CO.,
Worcester, Mass.



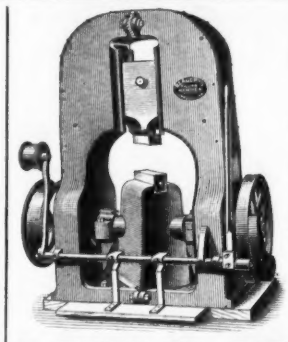
Pease Iron Planers.
All Sizes from 16 in.x16 in.x4 ft. to 36 in. x36 in.x12 ft. inclusive carried in stock.
HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON, MASS.

Machinists' Fine Tools
STANDARD TOOL CO., ATHOL, MASS.
SEND FOR NEW CATALOGUE

ALUMINUM $2 PER POUND.
THE PITTSBURGH REDUCTION COMPANY,
95 Fifth Avenue, Pittsburgh, Pa., U. S. A., offer commercially pure aluminum at the following rates at Pittsburgh, Pa.:
Lots of 1,000 lbs. and over.....$2.00 ℔
Lots of 500 lbs. and over..... 2.25 ℔
Lots of 100 lbs. and over..... 2.50 ℔
Metal guaranteed to be equal in quality to the best metal manufactured by any other process.
Prices on sheets, wire, tubes or castings, given upon application.

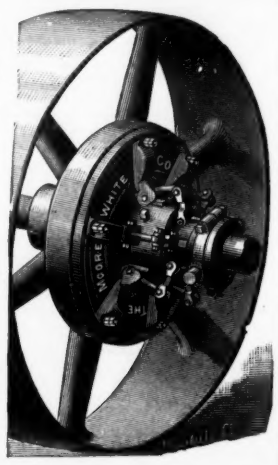


GUIDE PULLEYS FOR LIGHT BELTS.
JOHN ROYLE & SONS, PATERSON, N. J.

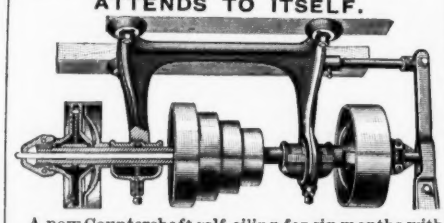


BEAUDRY'S NEW POWER HAMMER.
Send for Descriptive Circular.
BEAUDRY & CO.,
Sole Manufacturers.
Also Manufacturers of
Hard Coal Heating Forges.
Room 4, Mason B'dg,
70 KILBY ST., BOSTON, MASS.

THE MOORE & WHITE CO.,
Philadelphia, Pa.
Friction Clutch Pulleys, Cut-off Couplings, &c.

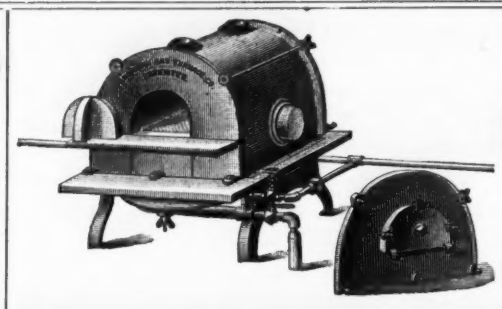


ATTENDS TO ITSELF.



A new Countershaft self-oiling for six months with self-oiling loose pulleys, new and perfect friction clutch. Please send for circulars.
THE STATES MACHINE CO.
R. R. Place & Commerce St., Newark, N. J.

W. C. YOUNG & CO., Worcester, Mass. Manufacturers of
Engine Lathes, Hand Lathes,
FOOT POWER LATHES, SLIDE RESTS, ETC.



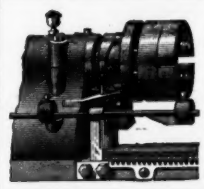
American Gas Furnace Co.,
Designers and Manufacturers
GAS BLAST FURNACES.
Send for Catalogue. Estimates made for any mechanical operation requiring **high, even** and **controllable temperature.**
No. 80 NASSAU STREET
NEW YORK.

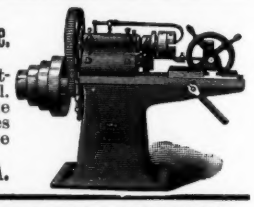
FINE TAPS, DIES, REAMERS, ETC.

LIGHTNING AND GREEN RIVER SCREW PLATES.
Bolt Cutters, Hand and Power Drilling Machines, Punching Presses, Tire Benders, Tire Upsetters and Other Labor-Saving Tools. Send for Price List.
WILEY & RUSSELL MFG. CO., GREENFIELD, MASS.

HEAVY AND LIGHT **CASTINGS** IRON OR BRASS
ARTHUR R. KING FOUNDRY & MACHINE WORKS,
ERIE, 11th & 12th STS., JERSEY CITY, N. J.
GENERAL MACHINE WORK. CORRESPONDENCE INVITED.

ADAMS
Automatic Bolt-Threading & Nut Tapping Machine.
Made in all Sizes to Cut from 1-4" to 6".
The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list to
Capitol Mfg. Co., 125 to 137 Rees St., Chicago, Ill., U. S. A.





"PRACTICAL DRAWING."
By J. G. A. MEYER.
This valuable series of 93 articles having been concluded, copies of the **American Machinist** containing them will be sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies, 5 cts. each, postpaid.

Order now before our stock of papers is exhausted.
ADDRESS:
American Machinist,
96 FULTON ST.,
NEW YORK.

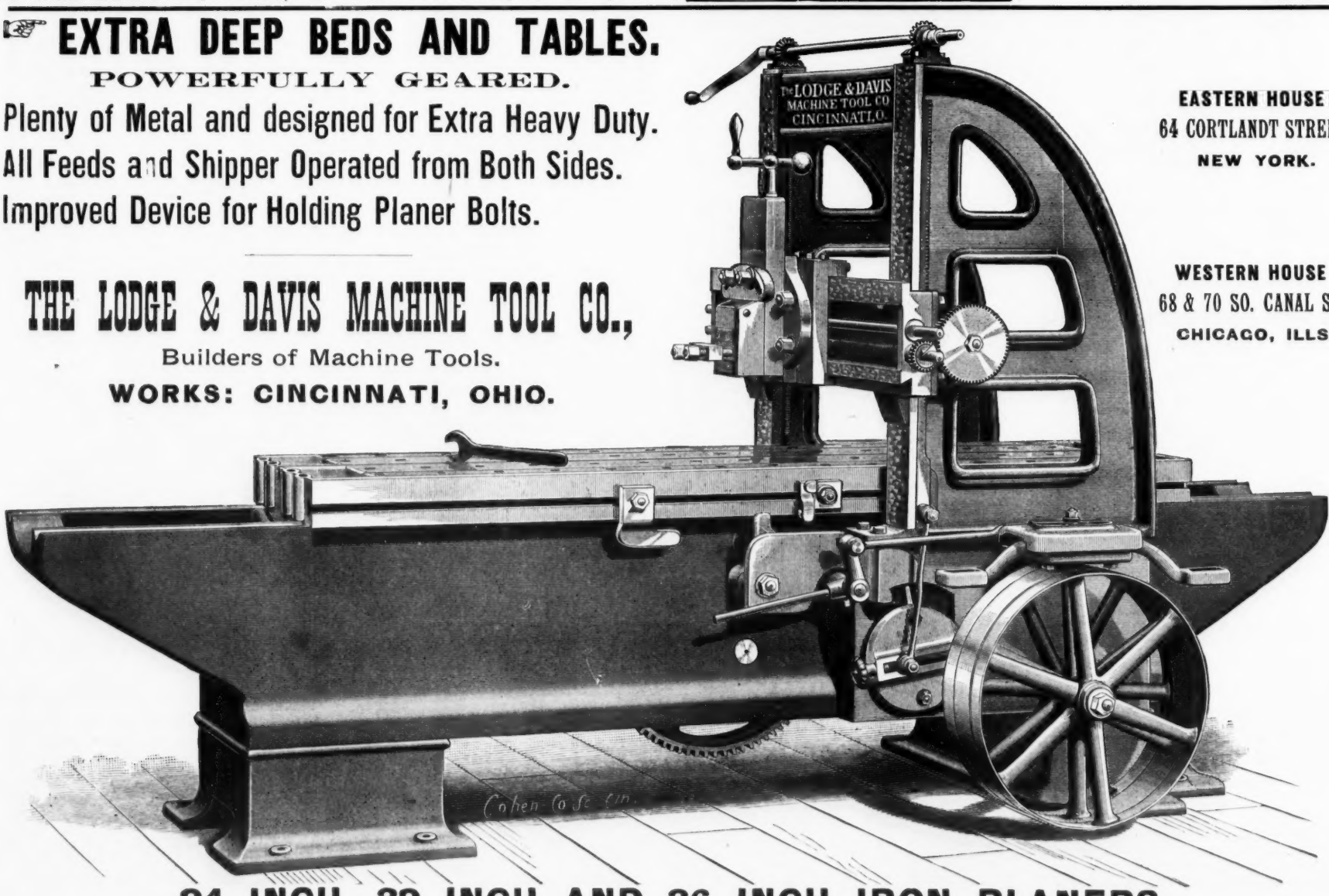
"MODERN LOCOMOTIVE CONSTRUCTION."
By J. G. A. MEYER.
This valuable series of 106 articles having been concluded, copies of the **American Machinist** containing them will be sent by mail to any address in the U. S., Canada or Mexico, for $5.30, or single copies, 5 cts. each, postpaid.

THE PECK PATENT DROP PRESS
MINER & PECK MF'G CO.
SUCCESSORS TO BEECHER & PECK
NEW HAVEN, CONN.
DROP FORGINGS

SAWYERS SAY OF SAWS FILED ON ROGERS' SAW FILER AND GUMMER, THAT OF ALL THE SAWS THEY EVER FILED THEY NEVER FILED AS THESE SAWS
Drop a postal card in the slot and get a Catalogue.
SAMUEL C. ROGERS & CO.,
BUFFALO, N. Y.

EXTRA DEEP BEDS AND TABLES.
POWERFULLY GEARED.
Plenty of Metal and designed for Extra Heavy Duty.
All Feeds and Shipper Operated from Both Sides.
Improved Device for Holding Planer Bolts.

THE LODGE & DAVIS MACHINE TOOL CO.,
Builders of Machine Tools.
WORKS: CINCINNATI, OHIO.



EASTERN HOUSE:
64 CORTLANDT STREET,
NEW YORK.

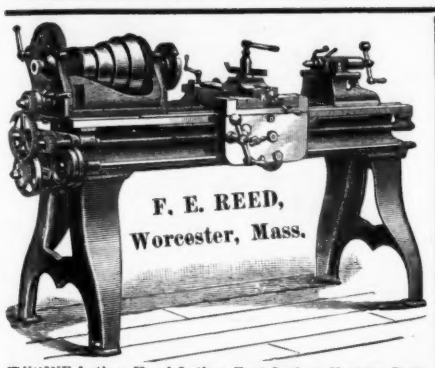
WESTERN HOUSE:
68 & 70 SO. CANAL ST.,
CHICAGO, ILLS.

24 INCH, 32 INCH AND 36 INCH IRON PLANERS.

MORSE TWIST DRILL AND MACHINE COMPANY, New Bedford, Mass.

Manufacturers of Morse Patent Straight-Lip Increase Twist Drills.

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.



ENGINE Lathes, Hand Lathes, Foot Lathes, Upright Drills and Milling Machines. Agents, MANNING, MAXWELL & MOORE, 111 LIBERTY STREET, NEW YORK.

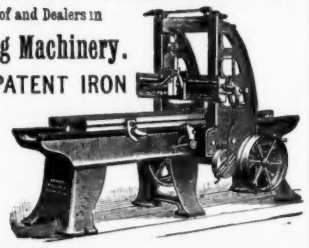
FLATHER ENGINE LATHES

14, 15, 16, 18, 20, 24 and 28 INCH SWING.
ANY LENGTH OF BED UP TO 22 FEET.

HILL, CLARKE & CO.,
General Selling Agents,
156 OLIVER ST., BOSTON, MASS.

L. W. POND MACHINE CO.

Manufacturers of and Dealers in
Iron Working Machinery.
IMPROVED PATENT IRON PLANERS A SPECIALTY.
152 Union St., WORCESTER, MASS.



LARGE IRON PLANERS

QUICK DELIVERY. LOW PRICES.
SEND FOR SEPTEMBER DELIVERY SHEET.

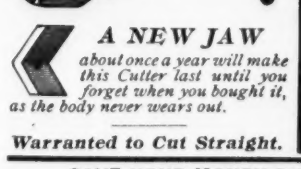
HILL, CLARKE & CO.,
156 Oliver Street, Boston, Mass.

BORING AND TURNING MILLS, 4, 5 and 6 Ft. SWING.

H. BICKFORD,
LAKE VILLAGE N. H.

THE "EUREKA" PIPE CUTTER
IS THE BEST AND CHEAPEST MADE.

No. 1 Cuts ⅛ to 1 inch Pipe $1.00
No. 2 " ¾ to 2 " " 1.50
No. 3 " 1 to 2 " " 4.65
Nos. 1 and 3 will cut all sizes from ⅛ to 3 inch



A NEW JAW
about once a year will make this Cutter last until you forget when you bought it, as the body never wears out.

Warranted to Cut Straight.

Any Jobber can furnish this tool to you at these prices.

PANCOAST & MAULE,
243 and 245 South Third Street, Philadelphia.

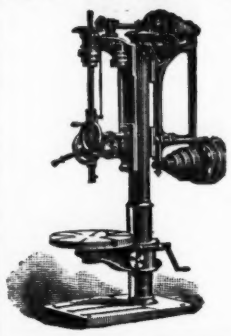
SAVE YOUR MONEY BY USING
RIDER'S
"Victor" Lathe and Planer Tool.

Cutters made direct from bar of Round Steel. *No fitting* required. Send Square or for prices.

FRANK L. B. RIDER, South Newmarket, N. H.

NEW HAVEN MANUF'G CO.,

New Haven, Conn.



Lathes, Planers, Shapers, Slotters, Etc.

JUST OUT.

OUR NEW ILLUSTRATED CATALOGUE OF

Turret Machinery.

MANY NEW FEATURES.

JONES & LAMSON MACHINE CO.,
SPRINGFIELD, VERMONT.

SEND FOR IT.

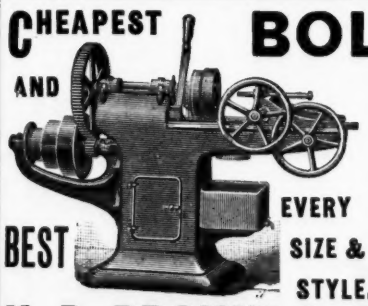
THE NATIONAL Feed-Water HEATER.

A brass coil Heater delivering water to the boiler at 210° Fahrenheit.

300,000 Horse Power sold. Prices Low. Satisfaction universal.

THE NATIONAL PIPE BENDING CO.,
82 River Street, NEW HAVEN, CONN.

CHEAPEST AND BEST BOLT CUTTERS.



EVERY SIZE & STYLE.

H. B. BROWN & CO.,
EAST HAMPTON, CT.

MACHINERY

For Reducing and Pointing Wire.

ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.

For Machines or Information, address the Manufacturer,

S. W. GOODYEAR, Waterbury, Ct.

SCROLL SAWS

THE
FLEETWOOD & DEXTER
ARE THE BEST.

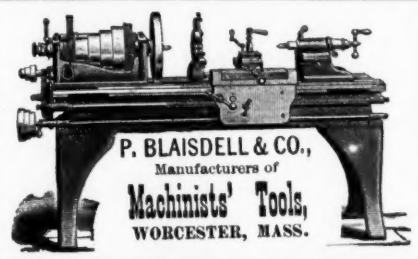
THOUSANDS SOLD.

Write for Illustrated Price Lists to

TRUMP BROS. MACH. CO.
Manufacturers.
WILMINGTON, DEL., U. S. A.

BOYNTON & PLUMMER,
WORCESTER, MASS.
Manufacturers of
Shaping Machines, Drilling Machines, Bolt Cutting Machines.

Send for Catalogue.



Blaisdell Engine Lathes.

All Sizes from 14 in. to 30 in. swing carried in stock.

HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON, MASS.

STUBS PATTERN | RIFFLERS | NEEDLE FILES | GROBET PATTERN STUBS | WORLD THE BEST IN

FILES

McFADDEN CO.,
735 MARKET ST., PHILADELPHIA.

SEND FOR CATALOGUE.
WORCESTER MACHINE SCREW CO.

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

MACHINIST'S SCALES,
PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
COFFIN & LEIGHTON, SYRACUSE, N. Y.

WORK SHOPS

Of Wood and Metal Workers without Steam Power, Equipped with Outfits of

BARNES' PATENT
Foot Power Machin'y

allow lower bids on jobs, and greater profits than by any other means for doing work. Sold subject to trial in your shop. Send for Price-List Catalogue.
W. F. & JNO. BARNES CO.,
Address 199 Ruby St., ROCKFORD, ILL.

Barnes' Foot-Power Machinery

Complete outfits for Actual Workshop Business. A customer says: "Considering its capacity and the accuracy of your No. 4 Lathe, I do not see how it can be produced at such low cost. The velocipede foot-power is simply elegant. I can turn steadily for a whole day, and at night feel as little tired as if I had been walking around." Descriptive Price List Free.

W. F. & JOHN BARNES CO.,
1995 RUBY ST., ROCKFORD, ILL.

Superior Swiss Drawing Instruments. Extra and Best Quality, German Drawing Instruments, Paragon, Duplex, Universal, Anvil Drawing, Hellos, Blue Process Papers, Scales, Triangles, T-Squares, Drawing Boards, Standard Profile and Cross-section Papers.

Catalogue to professional people on application.

D. SAUNDERS' SONS

MANUFACTURERS OF THE ORIGINAL
TRADE **I. X. L.** MARK.

PIPE CUTTING & THREADING MACHINE.

BEWARE OF IMITATIONS.
None genuine without our Trade-Mark and Name.
Steam and Gas Fitters' Hand Tools. Pipe Cutting and Threading Machines for Pipe Mill use a specialty.
Send for Circular. **YONKERS, N. Y.**

WILLIAM BARKER & CO.,

Manufacturers of
Iron and Brass Working
MACHINERY,
140 & 142 E. SIXTH ST.,
Near Culvert,
CINCINNATI, O.
Send for Circulars and Prices.

CURTIS & CURTIS,
66 Garden St., Bridgeport, Ct., U. S. A.
MANUFACTURERS OF
The Forbes Pat. Die Stock,
IMPROVED AND PERFECTED.
Pipe Cutting and Threading Machine, etc.

A portable cutting and threading machine with which one man can with ease thread pipe up to six inch diam. No vise is required.
SEND FOR ILLUSTRATED CATALOGUE.
Ratchet Drills, Ratchet Die Stocks and Malleable Iron Pipe Vises.

DROP FORGING.

SPEIRS & MOORE, WORCESTER, MASS.

THE "FOWLER" SPEED INDICATOR.
Counts to 5000. Price, $2.00.
CHANDLER & FARQUHAR,
177 Washington St., Boston.
Send for Catalogue.

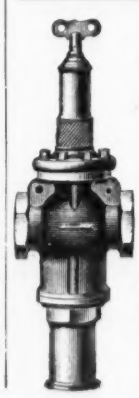
GLEASON MACHINE TOOLS

Engine Lathes, 22 inch to 72 inch swing.
Iron Planers, 26 inch to 84 inch wide.

HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON.

STEVENS PATENT
RELIABLE DIVIDER. No. 60

Forged from heavy stock. Operated with a right and left hand screw. Made with two tension screws, removing any back lash.
5 inches, price per pair.....$1.50
Ideal and Leader Spring Calipers and Dividers, Ideal Surface Gauges, Depth Gauges, and Fine Machinists' Tools.
Illustrated catalogue free to all.
J. STEVENS ARMS & TOOL CO.,
P. O. Box 231 Chicopee Falls, Mass.

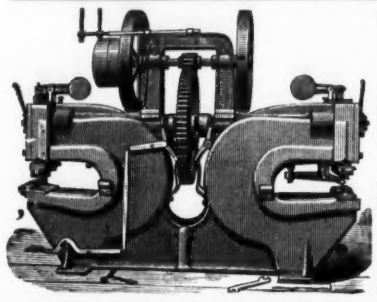


PUMP
Pressure Regulators.

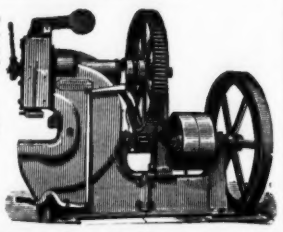
This Regulator is the standard used by all the large pump manufacturers; applicable to fire sprinkler systems, to water-works and other pumping machinery.

MASON REGULATOR CO.,
BOSTON.

WILLIAM SELLERS & CO., Incorporated.
PHILADELPHIA, PA.
BUILDERS OF
MACHINE TOOLS FOR WORKING IRON AND STEEL
Improved TURNTABLES for LOCOMOTIVES, CARS and PIVOT BRIDGES.
High Speed Power Traveling Cranes and Hand or Power Swing Cranes, Shafting, Pulleys, Hangers, &c., for transmission of power. Improved Self-Adjusting Injector of 1876. Self-Acting Injector of 1887. Fixed-Nozzle Automatic Injector of 1885.
INJECTORS for ALL CONDITIONS of LOCOMOTIVE and STATIONARY SERVICE.

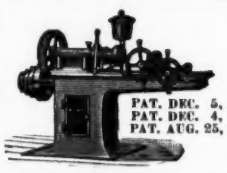


THE LONG & ALLSTATTER CO. Hamilton OHIO.
Double, Single, Angle-Bar, Gang, Horizontal, Twin, Boiler, Spacing, Gate, Multiple, Belt and Steam-Driven
Punches and Shears,
OVER 300 SIZES.
ALSO
Power Cushioned Hammer.
Send for New Catalogue.



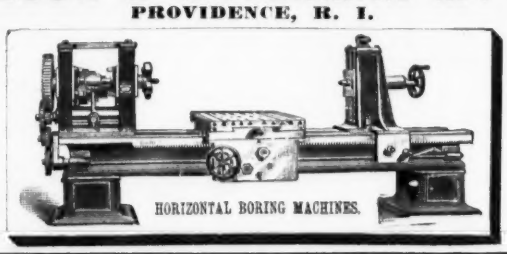
OPEN SIDE IRON PLANERS FOR IMMEDIATE DELIVERY.
One 30 in.x25 in.x6 ft.
One 30 in.x25 in.x6 ft. with Extra Side Head.
Two 30 in.x25 in.x8 ft.
One 36 in.x30 in.x8 ft.
One 48 in.x48 in.x14 ft. with Extra Side Head.
One 48 in.x48 in.x16 ft. with Extra Side Head.
THE DETRICK & HARVEY MACHINE CO.,
BALTIMORE, MD.

ACME MACHINERY CO.
CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single & Double Automatic BOLTCUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.
FIRST PREMIUM, CINCINNATI CENTENNIAL.



PAT. DEC. 5, 1882.
PAT. DEC. 4, 1883.
PAT. AUG. 25, 1885.

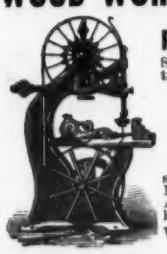
NICHOLSON & WATERMAN M'F'G CO.,
PROVIDENCE, R. I.
LATHES.
CUTTING-OFF MACHINES,
TRAVERSE DRILLS,
TRAVERSE BORING MACHINES,
SPECIALS,
&c., &c.



BOLT & NUT MACHINERY.
BROACHING MACHINES,
FACING MACHINES,
BOLT LATHES,
STAY BOLT THREADERS,
&c., &c.

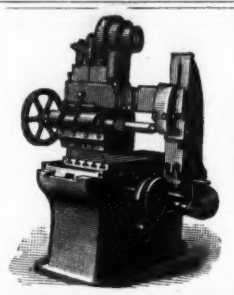
IMPROVED WIRE CUTTERS.
No. 1 cuts wire rods without leaving burr from ¼ in. to smallest size. Price, $7.00 each.
No. 2 cuts sizes from ⅛ in. to smallest size. Price, $12.00 each. Send $1.00 for 550-page illustrated catalogue of fine tools and supplies. No charge made when $10.00 worth of goods are ordered.
FRASSE & CO.,
92 Park Row, New York.

J. A. FAY & CO. CINCINNATI, OHIO, U.S.A.
BUILDERS OF IMPROVED
WOOD-WORKING MACHINERY
Embraces nearly 400 Machines for
PLANING & MATCHING
Surfacing, Moulding, Tenoning, Mortising, Boring, and Shaping, etc.
Variety and Universal
WOOD WORKERS.
Band, Scroll and Circular Saws, Resawing Machines, Spoke and Wheel Machinery, Shafting, Pulleys, etc. All of the highest standard of excellence.
W. H. DOANE, Pres. D. L. LYON, Sec'y.



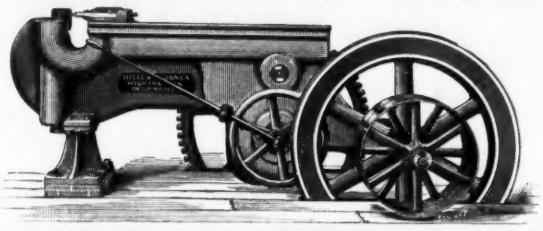
8,200 Copies of "PRAY'S BOOK,"
20 YEARS WITH INDICATOR
Sold to March 30th, 1890. Vols. 1 and 2 in one vol., $2.50.
JOHN WILEY & SONS, 53 E. 10th St., N. Y.

EMPLOYERS' LIABILITY ASSURANCE Corporation Limited London-Eng.
Deposited in the U. S. $700,000.00.
Policies issued giving full protection to Employers against loss by Claims from Employees on account of Accident. Rates Proportioned to Risks of Occupation. One Premium the only Payment during year. No Contingent or other Liability on part of Employer.
CHIEF OFFICE IN THE UNITED STATES:
71 KILBY ST., BOSTON, MASS.
ENDICOTT & MACOMBER,
Managers and Attorneys.
BOSTON: Samuel Appleton, 28 Central St.
NEW YORK: Kirby & Dwight, 51 Cedar St.
PHILADELPHIA: Tattnall Paulding, John G. Hoover, 416 and 420 Walnut St.
CHICAGO: Geo. A. Gilbert, 226 and 228 La Salle St.
ST. LOUIS: F. D. Hirschberg Bro., 120 N. Third St.
AGENTS IN ALL THE PRINCIPAL CITIES.



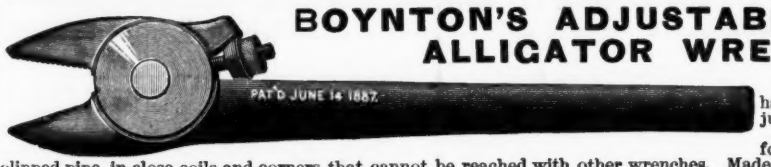
BEMENT, MILES & CO.,
PHILADELPHIA, PA.
—BUILDERS OF—
METAL-WORKING MACHINE TOOLS
FOR
Railroad Shops, Locomotive and Car Builders, Machine Shops, Rolling Mills, Steam Forges, Ship Yards, Boiler Shops, Bridge Works, Etc., Etc.

The HILLES & JONES CO., WILMINGTON, DELAWARE,



MANUFACTURERS OF
MACHINE TOOLS,
FOR
BOILER MAKERS, BRIDGE BUILDERS, SHIP BUILDERS, RAILROAD SHOPS, LOCOMOTIVE AND CAR BUILDERS, ETC., ETC.
HORIZONTAL FLANGE PUNCHES, ALL SIZES.

THE AERATED FUEL COMPANY,
425 MAIN STREET, SPRINGFIELD, MASS. J. H. BULLARD, MANAGER.
FORGING AND WELDING BY PETROLEUM AIR BLAST.
ALL OIL BELOW BURNERS! NO SMOKE, DIRT OR ASHES!
Represented by WILLIAM PICKETT, SON & CO., 170 Lake St., Chicago. W. S. COLLINS, Temple Court, 7 Beekman Street, Rooms 814-816, New York. CHILON JONES, Gananoque, Can. G. M. SMITH, Los Angeles, Cal. C. S. BARROWS, 46 Wade Building, Cleveland, Ohio, Michigan and Indiana. GILBERT & BARKER MFG. CO., General Agents for the United States, Springfield, New York and Boston. THOMAS, SHEPARD & SEARING, Arapahoe Building, Denver, Col. Sept. 29, 1885 July 5, 1887 Feb. 5, 1889 July 23, 1889
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.



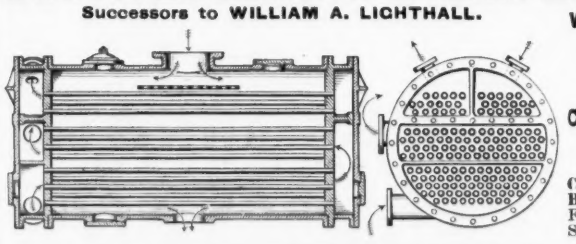
BOYNTON'S ADJUSTABLE ALLICATOR WRENCH.
Quick and handy in adjustment. Invaluable for work on clipped pipe, in close coils and corners that cannot be reached with other wrenches. Made entirely of drop forged steel. *Four sizes.*
CAMPBELL PRINTING PRESS AND MFG. CO., MFRS.
160 WILLIAM ST., NEW YORK. 325 DEARBORN ST., CHICAGO.

Our Location, Foundry Capacity and Machine and Pattern Shop Equipment afford us **special facilities for furnishing HEAVY CASTINGS TO ORDER,** in any quantity up to size 20,000 lbs., or **SMALL CASTINGS** where large quantities are required. Get our estimates and prices before ordering.
ALLENTOWN FOUNDRY & MACHINE CO.,
3d and Walnut Streets, ALLENTOWN, PA.

WYMAN & GORDON,
WORCESTER, MASS.

DROP FORGINGS.

SOUTH BROOKLYN STEAM ENGINE WORKS,
Successors to WILLIAM A. LIGHTHALL.
VAN BRUNT AND SUMMIT STS.,
BROOKLYN, N. Y.
New York Office, 69 Wall St.

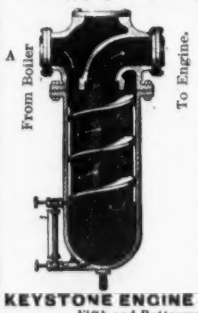


BUILDERS OF THE
Combined Surface Condenser and Feed Water Heater.
Lighthall Surface Condensers with Cobb's Improvements. Light Weight Brass Condensers a Specialty. Also Feed Water Heaters, Tube Heads, Screw Glands, &c.

L. S. STARRETT,
Manufacturer of
FINE TOOLS,
ATHOL, MASS.
SEND STAMP FOR FULL LIST.

DRAWING INSTRUMENTS,
200 page Catalogue sent on mention of this Journal, by
C. S. WOOLMAN,
116 Fulton Street,
NEW YORK.

SIMPSON'S CENTRIFUGAL SEPARATOR,
For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.

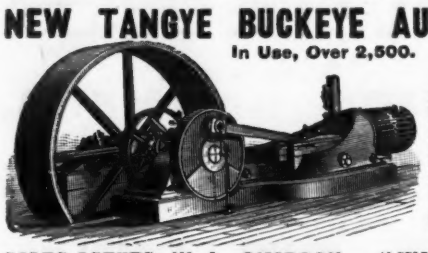


Simpson's Centrifugal Separator and Trap.
For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.
Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or top, as convenience may require; also used in conveying steam long distances, for Steam Hammers and Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.
KEYSTONE ENGINE AND MACHINE WORKS
Fifth and Buttonwood Streets, Philadelphia,
Or, A. T. ARTHUR, Selling Agent, 18 Cortlandt St., N. Y.

THE STRATTON SEPARATOR
DELIVERS
DRY STEAM
To your engine or for any other purpose, no matter HOW LONG YOUR STEAM PIPE, or how much your BOILER MAY PRIME. An absolute safeguard. A source of economy.
— THE —
Stratton Separator Co.,
32 Cortlandt St., NEW YORK.

NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES

In Use, Over 2,500. 25 to 1,000 H. P.



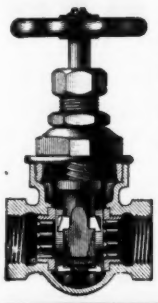
These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for Driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

SALES AGENTS: W. L. SIMPSON, 10 TELEPHONE BUILDING, 18 CORTLANDT STREET, N. Y. / N. W. ROBINSON, 154 Washington St., Chicago, Ill. / ROBINSON & CARY COMPANY, St. Paul, Minn.

KENSINGTON ENGINE WORKS, LIMITED, PHILADELPHIA.

Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland, and Virginia.

BLESSING'S RENEWABLE-SEAT GLOBE, STRAIGHTWAY and CHECK VALVES.

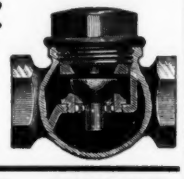


The Renewable-Seats and Disks are cast from the best Phosphor Bronze Metal, which has lasting qualities double that of the best Steam Metal commonly used in first-class valves. The seats are simply screwed to place by the use of a special wrench furnished with each valve.

These valves are equally applicable to steam, water, or other fluid pressure.

We also manufacture **Blessing's Albany Steam Traps, Water Circulator and Purifier; and Pump Governor.**

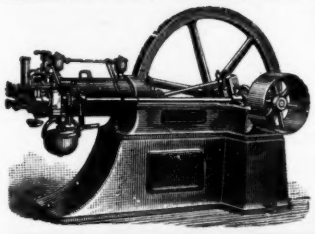
SEND FOR CIRCULAR.



ALBANY STEAM TRAP CO.,

ALBANY, N. Y.

"OTTO" GAS ENGINE WORKS.



SCHLEICHER, SCHUMM & CO.,

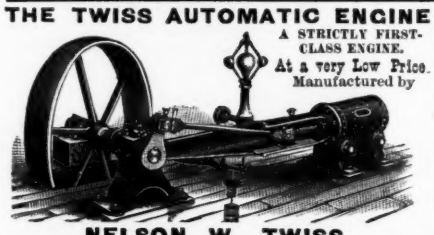
33d and Walnut Sts., PHILADELPHIA. Branch Office, 151 Monroe St., CHICAGO.

OVER 35,000 ENGINES IN USE.

GUARANTEED To consume 25 to 75 Per Cent. Less Gas than ANY Other Gas Engine doing the same work.

THE TWISS AUTOMATIC ENGINE

A STRICTLY FIRST-CLASS ENGINE. At a very Low Price. Manufactured by



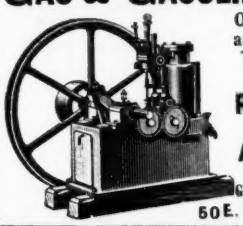
NELSON W. TWISS,

25 Whitney Ave., New Haven, Conn.

Send for Price before Purchasing Elsewhere.

ALSO VERTICAL AND YACHT ENGINES.

VAN DUZEN GAS & GASOLINE ENGINE



OPERATED with COAL and OTHER MANUFACTURED GASES AND GASOLINE.

RELIABLE AND ECONOMICAL.

Fully Warranted

VAN DUZEN Gas & Gasoline Engine Co.

50 E. 2d St., Cincinnati, O.

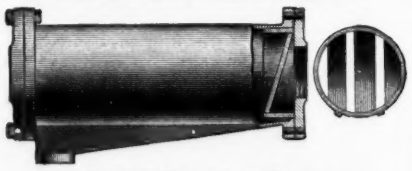
BARNARD'S SEPARATOR

For Separating and Removing Entrained Water from Live Steam;

AND

Condense Water, Oil, Dirt, Etc., from Exhaust Steam.

SPECIAL DESIGNS FOR SURFACE CONDENSERS.



SEND FOR CIRCULAR AND PRICES.

GEO. A. BARNARD,

15 CORTLANDT ST., NEW YORK.

OUR NEW CATALOGUE OF TOOLS

And Supplies sent free to any address on receipt of Ten Cents in Stamps (for postage).

Chas. A. Strelinger & Co., WOOD AVE. Detroit, Mich

MACHINE TOOLS

FOR IMMEDIATE DELIVERY.

One Driving Wheel Lathe 70" swing; second-hand.
One Fitchburg Engine Lathe 24" by 16'; new.
One Lathe and Morse Lathe 32" by 17'; new.
One Lathe and Morse Lathe 36" by 15'; new.
One Gray Planer 30" x 30" x 8'; new.
One Pease Planer 34" x 32" x 8'; new.
One Pease Planer 36" x 36" x 8'; special; new.
One Powell Planer 30" x 30" x 10'; new.
One Pond Planer 38" x 38" x 12' with 2 heads; new.
One Powell Planer 48" x 48" x 14' with 2 heads; new.
One No. 4 Brainard Milling Machine.
One Detrick and Harvey Open Side Planer, size C, with supplemental rolling table and extra saddle on post.

Send for complete List of New and Second-hand Tools.

HILL, CLARKE & CO.,

156 Oliver Street, Boston, Mass.

BRAINARD GEAR CUTTING MACHINES.

18 In., 24 In., 36 In., 48 In.

HILL, CLARKE & CO.,

General Selling Agents,

156 OLIVER ST., BOSTON, MASS.

NEW AND SECOND HAND MACHINERY

FOR IMMEDIATE DELIVERY.

The following second hand Tools we have replaced with our **IMPROVED NEW ONES** and will close them out low.

Putnam,	Engine	Lathe,	13 in. swing,	4 1-2 ft. Bed.
New Haven,	"	"	16 in. "	6-8 ft. "
Lathe & Morse,	"	"	16 in. "	6 ft. "
Fitchburg,	"	"	16 in. "	8 ft. "
Ferris & Miles,	"	"	17 in. "	8 ft. "
New Haven,	"	"	18 in. "	8 ft. "
Wood & Light,	"	"	20 in. "	7 1-2 ft. "
Townsend	"	"	21 in. "	7 ft. "
Fifield	"	"	22 in. "	14 ft. "
New Haven,	"	"	25 in. "	10 ft. "
Heavy pattern,	"	"	25 in. "	15 ft. "
Heavy pattern,	"	"	25 in. "	23 ft. "
Leonard,	"	"	38 in "	18 ft. "

Am. Tool Co., No. 2 Cabinet Turret Lathe.
Gage, Square Arbor Fox Lathe, 15x5.
Badger, Planer, 24 in.x 6 ft.
Snyder, " 24 in.x 6 ft., grinding head.
New Haven, " 24 in.x 7 ft.
Pond, " 26 in.x 8 ft.
New Haven, " 30 in.x 8 ft.
New Haven, " 32 in.x10 ft.
Old Style, Shaper Crank, 12 in. stroke.
Lincoln Pattern Milling Machine.
Brown & Sharpe, No. 2 Screw Machine.
Jones & Lamson, No. 4 do. wire feed.
Brown & Sharpe, 18 in. Automatic Gear Cutter.

NEW TOOLS

On Hand and Early Deliveries.

Fitchburg Machine Works, Lathes and Planers.
Prentice Bros., Lathes, 14-16 18 in.
Hendey Machine Co., Lathes, 16x6 and 8 ft.
Lathe & Morse, Lathes, 21-27-32 in.
Wright Machine Works, Lathes, 16-20-24 in.
Fay & Scott, Lathes, 28-32 in.
McMahon, Lathes, 16 20 in.
Prentice Bros. Drills, 20-21-25-28-32 in.
Powell Planer Co., Planers, 22-24-30-36 in.
Gould & Eberhardt, Shapers, 16 24 in.

Large Assortment of other Tools, New and Second Hand. Send for Complete List.

68 Cortlandt St., NEW YORK. **J. J. McCABE** Successor to **E. P. BULLARD'S** New York Machinery Warerooms.

MACHINE TOOLS

ENGINE LATHES,
BRASS LATHES,
BORING AND TURNING MILLS,
SCREW MACHINES,

on hand and in process of construction.

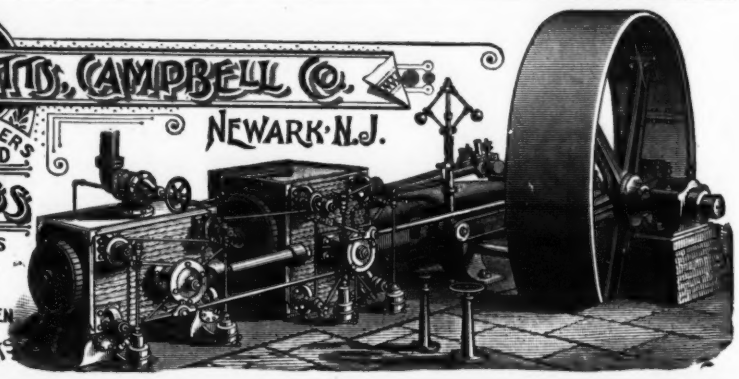
BRIDGEPORT MACHINE TOOL WORKS,

E. P. BULLARD, PROPRIETOR. BRIDGEPORT, CONN.

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

NEWARK, N. J.



CONTRACTS TAKEN FOR COMPLETE POWER PLANTS

Eclipse Corliss Engine.

FRICK COMPANY, Builders, WAYNESBORO, PA.

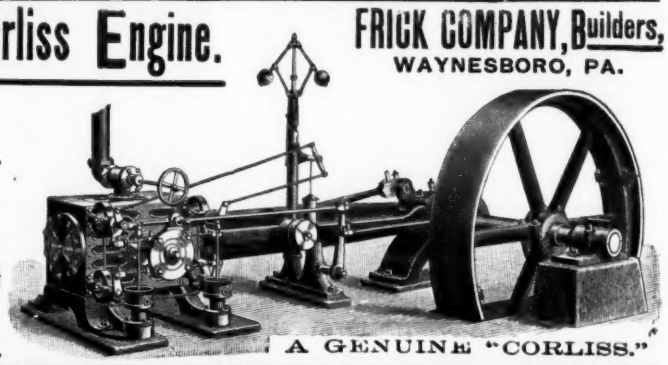
NON-CONDENSING, CONDENSING COMPOUND.

40 TO 1,000 H.P.

Send for Circulars.

ICE-MAKING AND REFRIGERATING MACHINERY.

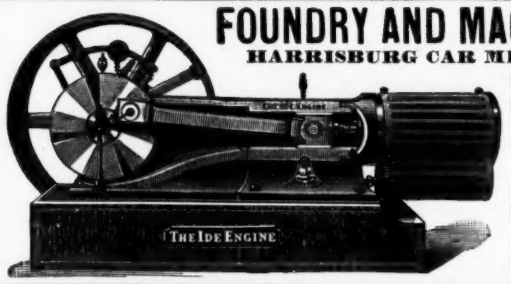
Send for Special Circular.



A GENUINE "CORLISS."

FOUNDRY AND MACHINE DEPARTMENT.

HARRISBURG CAR MFG. CO., HARRISBURG, PA.



THE IDE ENGINE

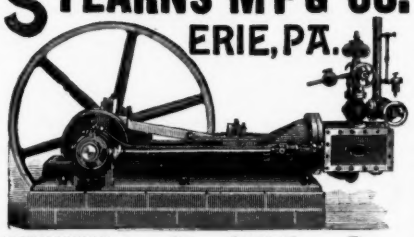
Highest Award SILVER MEDAL and DIPLOMA AT FRANKLIN INSTITUTE NOVELTY EXHIBITION, PHILADELPHIA.

We are operating the finest and most successful Electric Light Stations in the world. A change of speed not exceeding one per cent. guaranteed, running light and loaded. Send for catalogue.

New York Office, Fleming & Kimball, 17 Dey St. New England Office, John Post, Jr. & Co., 70 Kilby St., Boston. Baltimore Office, Thomas K. Carey & Bro., 35 Light St., Baltimore.

STEARNS M'F'G CO.

ERIE, PA.



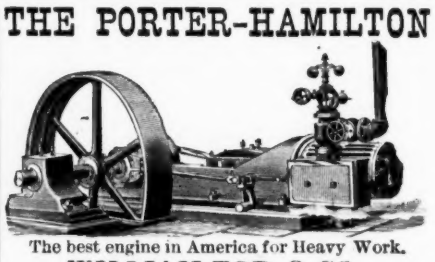
ENGINES from 15 to 400 Horse Power

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

SAW MILLS and GENERAL MACHINERY

NEW YORK STORE, 46 Cortlandt St.

THE PORTER-HAMILTON



The best engine in America for Heavy Work.

WILLIAM TOD & CO.,

Youngstown, Ohio.

CHANDLER & TAYLOR CO'S STEAM ENGINES

SELF-CONTAINED

Are tested under full load before shipment.

12 TO 80 H. P.

IN STOCK FOR QUICK DELIVERY.

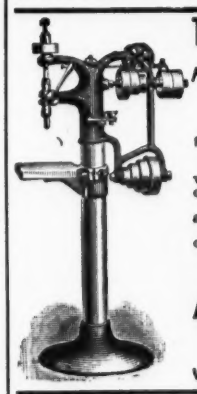
For Circulars address

CHANDLER & TAYLOR CO., INDIANAPOLIS, IND

FOR SALE. CORLISS ENGINES.

The Fishkill Landing Machine Co., located at **Fishkill, on the Hudson, N. Y.,** offer to manufacturers and others desiring a well-built, economical and durable engine, their improved **CORLISS ENGINES.** They are endorsed by many reputable engineers and persons using them. Address as above.

THE NORTON DRILLS.



FOR LIGHT, SENSITIVE AND RAPID DRILLING.

1, 2, 3, 4 or more Spindles, Sensitive or Automatic Feed.
To drill from 0 to 1-2 inch holes.
The *Latest* and *Best*; most convenient, sensitive and durable Drill on the market.
Have Balanced Spindles and Balanced Tables.
Write for prices and description, or for Special Machinery.

NORTON & JONES,

Machine Tool Works,

PLAINVILLE, CONN.

FORMERLY

W. P. NORTON, BRISTOL, CONN.

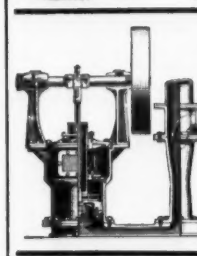
Corliss Engines

Of the highest type, in all sizes are made by

The Lane & Bodley Co.

CINCINNATI, O.

The merits of their engines are described in an illustrated pamphlet, which will be sent to any one interested.



Belt Power Air Pump and Condenser.

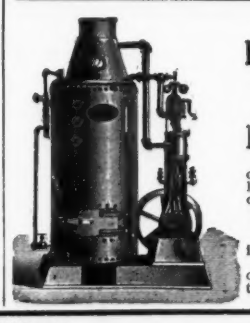
CONOVER & CO.,

CONSULTING AND MECHANICAL ENGINEERS

95 LIBERTY ST., NEW YORK.

No Air Locks. 15 to 50 per cent. fuel saved or equal amount of power gained. Runs with same economy as engine.

Adapted to all kinds of Engines. *Send for Circular.*



LANE'S Foundry & Machine WORKS,

HUNTINGDON, PA.

Fine Upright Engines.

The following sizes are carried in stock, made in large quantities, with special tools, at special prices:

3, 4, 5, 6, 7 & 9 H. P.

If you want one Engine, it will pay you to write us.

If you handle large quantities, it will pay you to write us.

BALL AUTOMATIC ENGINES.

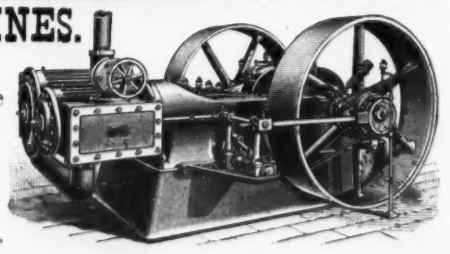
WORKS: ERIE, PA.

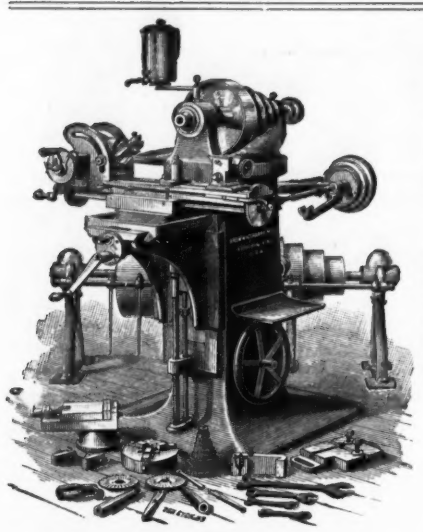
High-Pressure, Compound and Triple Expansion, Condensing and Non-Condensing.

CHARLES R. VINCENT & CO.,

Contracting Engineers,

15 Cortlandt St., NEW YORK. 38 Oliver St., BOSTON.





No. 1 Universal Milling Machine.
Made with and without overhanging arm.

THE ORIGINAL

Universal Milling Machines

Made by the

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I.,

Are kept in stock and sold at favorable prices, compared with any of their *IMITATIONS*. By making these Machines in large numbers, with expensive special tools, much greater accuracy has been attained than can be reached by the usual methods of manufacture. The importance of the greatest attainable accuracy in *TOOL-MAKING MACHINES* will be appreciated by Machinists.

Correspondence Solicited. Catalogue Mailed on Application.

WESTERN REPRESENTATIVE,

S. A. SMITH,

No. 23 SOUTH CANAL STREET,

CHICAGO, ILL.

NILES TOOL WORKS

HAMILTON, OHIO.

MACHINE TOOLS.

Car Wheel and Axle Machinery. Double Axle Lathes. Single Axle Lathes. Axle Cutting-off and Centering Machines. Car Wheel Boring Machines. Hydrostatic Wheel Presses. Car Wheel Turning Lathe.

NEW YORK, 98 Liberty St. PHILADELPHIA, 705 Arch St. PITTSBURGH, Lewis Block. CHICAGO, Phenix Building.

CRANES

THE YALE & TOWNE MFG CO.
STAMFORD CONN
NEW YORK CHICAGO PHILA BOSTON

The Original Unvulcanized Packing

CALLED THE STANDARD—As it is the Packing by which all others are compared.

Accept no packing as JENKINS PACKING unless stamped with our "Trade Mark."

JENKINS BROS. { 71 JOHN STREET, N. Y. / 105 MILK STREET, BOSTON. / 21 NORTH FIFTH ST., PHILA. / 54 DEARBORN STREET, CHICAGO.

ENGINE LATHES. PULLEY LATHES.
MONITOR AND FOX LATHES.
TURRET BORING LATHES.
EXTRA HEAVY IRON PLANERS.
TRIPLE GEARED AND CRANK SHAPERS.
UPRIGHT DRILLS WITH SPECIAL FEATURES.
IMPROVED MILLING MACHINES.

☞ MACHINE SHOP OUTFITS A SPECIALTY.

THE LODGE & DAVIS MACHINE TOOL CO.,

WORKS: CINCINNATI, O.

EASTERN HOUSE, 64 CORTLANDT ST., NEW YORK.
WESTERN HOUSE, 68 & 70 S. CANAL ST., CHICAGO.

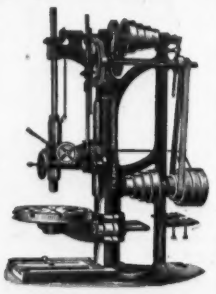
☞ SEE ADVERTISEMENT, PAGE 16.

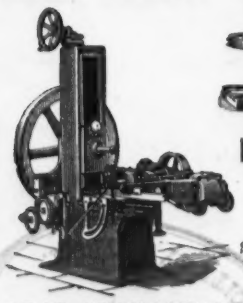
GOULD & EBERHARDT,

Near Market St. Depot,
NEWARK, N. J.

EBERHARDT'S PATENT

DRILL PRESS.





EBERHARDT'S Patent GEAR CUTTER.

Sizes, 18", 25", 36", 50", 60", 84".

GEAR AND RACK CUTTING TO ORDER.

WE HAVE JUST IMPORTED DIRECT
A LARGE
STOCK OF

Milling Cutter Blanks,

(ANNEALED),
FORGED BY
WILLIAM JESSOP & SONS, Limited,
Of their BEST

Cast Tool Steel.

Sizes, 4 inches Diameter, 5/8 inch Thick.
To 6 " " 2 1/4 " "
Varying by 1/4 inch in Diameter and Face.

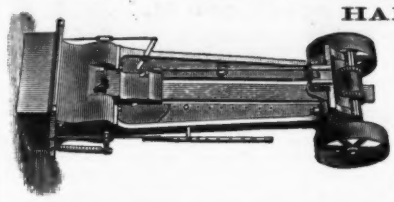
Price, 25 CTS. per lb.

THE GARVIN MACHINE CO.,

Laight & Canal Streets. NEW YORK.

THE PRATT & WHITNEY CO.,

HARTFORD, CONN.



MANUFACTURE

DROP HAMMERS,

PUNCHING AND TRIMMING PRESSES,

—POWER SHEARS.—

Die-Sinking Machines, Hand Bolt Heading, Power Screw and Bolt Blank Heading Machines.

RETRACTILE JIB CRANES,

Roll Grooving Machines for Flour Mill Use.

PRICE LIST AND DISCOUNT SHEET SENT UPON APPLICATION.

WESTERN BRANCH, 100 West Washington Street, Chicago, Ills.

THE BILLINGS & SPENCER CO., HARTFORD, CONN., U. S. A.

Manufacturers of Beach's Improved Patent Thread Cutting and Diamond Point Lathe Tool.

FURNISHED IN TWO SIZES, EITHER SIZE WITH BENT OR STRAIGHT HOLDER.

WE FURNISH CUTTERS FOR U. S. S. THREADS TO FIT THESE TOOLS.

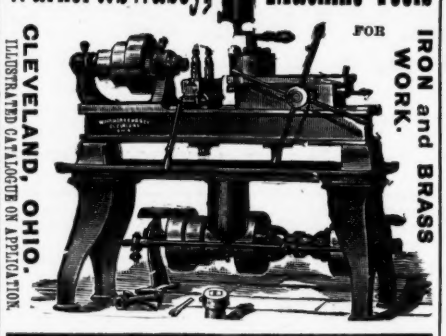
Send for Catalogue.

DROP FORGINGS OF BRONZE, COPPER, IRON & STEEL OF ALL DESCRIPTIONS.

Warner & Swasey, Machine Tools

CLEVELAND, OHIO. ILLUSTRATED CATALOGUE ON APPLICATION.

FOR IRON and BRASS WORK.



GEO. W. FIFIELD,

MANUFACTURER OF

ENGINE LATHES

FROM 16 to 48 IN. SWING.

Cuts, Photographs and Prices furnished on application.

Lowell, Mass., U. S. A.

Every machine or manufacturing concern should send for the list of 600 sizes of cut iron spur and bevel gear wheels and racks lately issued by the Lexington Gear Works, of Lexington, Miss.
(GRANT)

Key-Seating Machines and 20 in. Drills

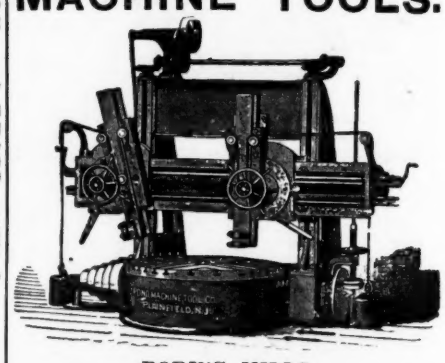
A SPECIALTY.
SEND FOR LIST OF
New and Second-Hand
Lathes, Planers, Drills,
or anything in Machinists' Tools or Supplies.

W. P. DAVIS,
Rochester, N. Y.
Works at North Bloomfield.

THE POND MACHINE TOOL CO.,

Formerly of Worcester, Mass.
MANUFACTURERS OF

MACHINE TOOLS.



BORING MILLS.

Radial Drills, Planers, Lathes, Heavy & Powerful, from new patterns of the latest and best designs.

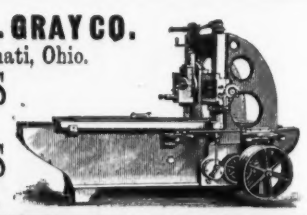
SALESROOM & OFFICE, 113 Liberty St., N. Y. City.
NEW SHOPS, PLAINFIELD, N. J.

J. M. ALLEN, PRESIDENT.
WM. B. FRANKLIN, VICE-PRESIDENT.
F. B. ALLEN, SECOND VICE-PRESIDENT.
J. B. PIERCE, SECRETARY & TREASURER.

THE G. A. GRAY CO.

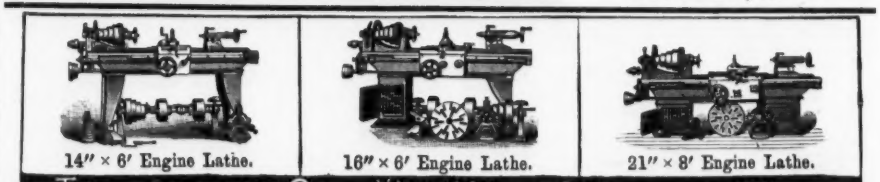
Cincinnati, Ohio.

PLANERS AND LATHES A SPECIALTY.



STEEL CASTINGS.

PRATT & LETCHWORTH,
PROPRIETORS
BUFFALO STEEL FOUNDRY,
BUFFALO, N. Y.



14" × 6' Engine Lathe. 16" × 6' Engine Lathe. 21" × 8' Engine Lathe.

THE HENDEY MACHINE CO. SEND FOR OUR CATALOGUE. MANUFACTURERS OF MACHINE TOOLS TORRINGTON CONN.

Manufacturer —of— TAPS & DIES